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NATURAL HISTORY.

MOLLUSCA.

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NATURAL HISTORY.

MOLLUSCA.

By P. H. GOSSE, A.L.S.

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NATURAL HISTORY.

MOLLUSCA.

The four Classes of animals which have been considered in the preceding volumes of this series we have seen to have one character in common; viz. the possession of a bony framework within the body, of which a jointed spine is the most essential element. This character, which unites those four Classes into one great group, and gives to that group the name Vertebrata, by which it is distinguished among naturalists, we have seen, however, by slow degrees, *deteriorated*, if I may use such an expression, from bone to cartilage, and gradually diminished in its development, until, in the lowest of the Fishes, it can scarcely be recognised at all.

I come now to treat of animals in which the bony skeleton no longer exists. The conditions of their existence do not require such a scaffolding on which to build the constituent muscles: many are habitually immersed in water, a fluid the density of which supports their soft bodies; their motions generally lack the precision, energy and variety of those which belong to Vertebrate animals; and where this is not the case, as in the Articulate Classes, the skeleton which affords attachment to the muscles, is not internal, but invests the body, while its substance differs essentially from bone in its chemical composition and its structure.

An immense assemblage of living creatures are included in this category; creatures differing widely from each other in the most important characteristics, so that they cannot be grouped together. The term INVERTEBRATA, by which they are sometimes designated, indicates indeed only a negative character, and we shall be greatly mistaken if we suppose (misled by such a term) that the animals which have a skeleton, and those which are destitute of one, constitute two primary divisions of living beings, of equal or co-ordinate importance.

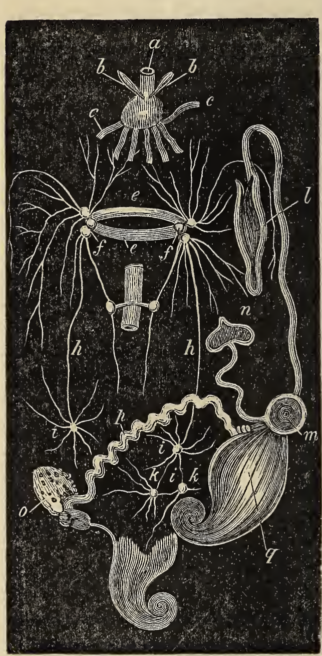
Several divisions of INVERTEBRATE animals do, in fact, exist, each one of which is equal in rank to the VERTEBRATA. One of these will form the subject of the present volume, commonly known by the name of MOLLUSCA; a term invented by the illustrious Cuvier, from the word *mollis* (soft), and evidently suggested by the softness of their boneless bodies. The appellation can scarcely be considered happy, for the character so indicated is very trivial, and is shared by other animals of totally different structure:—objectionable, however, as it is, it has been generally adopted, and I shall not hesitate to make use of it.

As the great Vertebrate Division includes the four distinct Classes of Beasts, Birds, Reptiles and Fishes, so does the great Division of MOLLUSCA contain six Classes, distinguished by characters which I shall presently enumerate. I must, however, first indicate those which they possess in common, and by which they are naturally grouped together.

The nervous system demands our first attention. Instead of a great mass of nervous substance accumulated in one place, and a lengthened spinal cord proceeding from it, giving out threads to all parts of the body, as in the VERTEBRATA, we find the nervous centres numerous, unsymmetrical and disposed in various parts of the system, no one having so decided a predominance over the others in bulk, as to merit the appellation of a brain. There is, however, one mass larger than the rest, which is always placed either above the gullet (*œsophagus*), or encircling it, in the form of a thickened ring; and from this the nerves that supply the organs of sense invariably originate. This mass, or *ganglion*, must undoubtedly be regarded as the representative of the brain; for in the most highly organized animals of the Division, the Squids and Cuttles (*Cephalopoda*), this encirling mass is enclosed and defended by a case of cartilage, the lingering rudiment of a bony skull.

The accompanying engraving, which is copied from Professor Grant's "Outlines of Comparative Anatomy," will give the reader an idea of the system of nerves and ganglia, with some of the other organs, as they appear in *Bulla lignaria*, a large and handsome shelled Mollusk found on the British coasts.

In the above figure the chief ganglion forms a ring, (marked *ee*,); anterior to this there is a small ganglion, not seen, because situated below the bulb of the gullet (*a*), just before the insertions of its diverging muscular bands (*c*), and behind the salivary glands (*b*). The brain-ring (*e*) has on each side a large three-lobed ganglion (*f*), whence numerous nerves pass to the surrounding parts, and two long branches (*h*) extend backwards along the sides of the abdomen, to two ganglia (*i*,*i*), placed above the muscular foot. Behind these are two sympathetic ganglia, (*k*,*k*), which send threads to the digestive system, the ovary (*o*), the oviduct (*p*), the uterine sac (*q*), the vulva (*m*), and the urinary organs (*n*). This may be considered as a fair average sample of the nervous system in the MOLLUSCA, being selected from a Class presenting neither the highest, nor the lowest forms of organization.



NERVES OF BULLA.

The nervous centres are, for the most part, grouped without regard to symmetry, those of one side not corresponding to those of the other; and this irregularity is characteristic of the whole Division, not only in the nerves, but in the other organs of the body. Some zoologists have derived from this peculiarity, a name for the Division, sufficiently expressive, though too uncouth for general adoption, that of HETEROGANGLIATA.*

All the senses common to the higher animals are found in the MOLLUSCA, though some are, doubtless, wanting in the humbler Classes of the Division. In the *Cephalopoda*, the organs of sight and hearing are distinct and well developed, and Professor Owen is of opinion that the Nautilus, an animal of this Class, possesses an organ of "passive smell." The *Gasteropoda* are almost invariably furnished with eyes; and, according to M. Siebold and other zoologists, with ears also, a pair of round capsules, placed near the bases of the tentacles, and enclosing one or more crystalline globules, called *otolites*. Some of the *Conchifera* are furnished with numerous eyes, placed among the tentacles, examples of which are found in the Clams and Scallops (*Pecten*) of our own shores. I scarcely know a more beautiful sight of the kind, than is presented by the edges of the mantle in one of our Scallops. If you ever have an opportunity of procuring a living specimen, which is not difficult to find at low water, on most of our rocky shores, place it in a glass of sea-water, and watch its movements. Soon the beautiful painted shells will begin to open, and the fleshy mantle will be seen to occupy the interval, like a narrow veil extending perpendicularly from each shell. The edge of each of these veils will now be seen, if you examine it with a pocket lens, to be fringed with long white threads, which are the tentacles, or organs of touch; and amongst them lie scattered a number of minute points, having the most brilliant lustre, and bearing a close resemblance to tiny gems. Indeed, the mantle has been aptly compared to one of those pincushions which are frequently made between pairs of these very shells, the eyes representing a double row of diamond-headed pins, set round the middle. It is observable that the Bivalves, which are thus profusely furnished with eyes, are also endowed with the faculty of precise and vigorous motion. It does not appear clear that any of this Class possesses a distinct sense of hearing.

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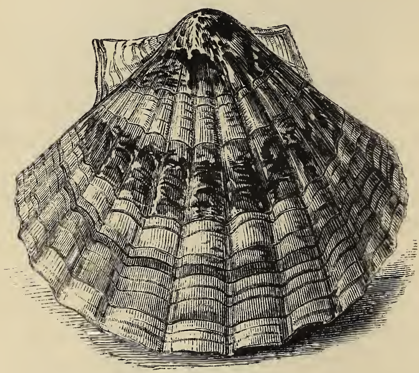
* That is, "having dissimilar nerve-knots."



THE GREAT SCALLOP.

The faculty of taste is plausibly *conjectured*, rather than *proved*, to belong to the Mollusca. "It seems necessary," says Dr. Johnston, "to suppose the existence of this sense in all Mollusca, for they select particular articles of food in preference to others; and we know no other sense which is fitted to regulate the choice." The organs appropriated to this faculty are probably the margins and internal surface of the mouth, and the tentacles which in some species are placed close to this orifice.

Every one who has touched a crawling Slug or Snail, must have had a practical proof of the delicacy of its sense of touch. The whole surface of the body, invested with a soft, flexible, and mucous skin, contracts on the slightest contact with any unexpected substance, and is, doubtless, an extended organ of feeling, probably much more sensitive than the naked skin of our bodies. But, besides this, most, if not all of these animals are furnished with organs of special touch called tentacles, which serve to collect and convey impressions of the proximity, the form, the hardness, and perhaps other qualities, of those bodies which the animals may desire to investigate. The mantle, also, in many of the *Gasteropoda*, is fringed with a number of filaments, often curiously branched, which are probably accessary organs of touch.

The sensitiveness manifested by some of the large *Gasteropoda*, the great Conchs of the West Indies, for example, to the presence of other bodies, even without contact, and which the Rev. Lansdown Guilding attributed to the sense of *hearing*, may, perhaps, rather be considered as a modification of *feeling*, capable of appreciating the pulsations of the atmosphere. The experiments of this naturalist, not to be vindicated from the charge of cruelty, are thus described. "I lately suspended," he says, "a number of large *Strombi* by the spire, that the animal, when dead, might fall from the shell. They had remained in this situation several days, till the body, weak and emaciated, hung down nearly a foot from the aperture, and the eyes had become dim. I found that even before my shadow could pass over them, they were aware of my presence, and endeavoured to withdraw into the shell. I then cut off the eyes, with the thick cartilaginous tentacula in which they were lodged, but the animals still continued to be sensible of my near approach, while hanging in this mutilated and painful condition." * Dr. Johnston records a manifestation of feeling, somewhat analogous to this, in one of the common shell-fish of our sandy shores. "On a summer evening," he remarks, "I have observed the common Spout-fish (*Solen siliqua*), extended along the surface of the fine sand in which they burrow, enjoying, apparently, the calmness and mildness of the season, take alarm and instantaneously descend when I was yet distant several yards: and I can explain this and similar facts only on the supposition of the existence of a sense of touch feelingly alive to impressions impalpable to our grosser sense." †

The respiration is aquatic in most of the MOLLUSCA. The breathing organs, in most cases, resemble in essential points the gills of fishes, consisting of a great number of leaves, often minutely subdivided. They are chiefly formed of blood-vessels, covered with rows of vibrating *cilia*, by the constant motion of which, currents of water are perpetually hurled along the entire surface of the breathing organ, communicating oxygen, the vital principle, to the blood as they go, through the thin walls of the vessels. In many species, as the Bivalves, the gills form two large comb-like plates; in others they are arranged in the form of a feather; a beautiful tribe, known as naked-gilled, have these organs placed on the outside of the body, sometimes forming prominent warts or *papillæ*, disposed in rows, or in tufts, sometimes resembling little branching trees, and at others, arranged as a number of elegant plumes, set, like the petals of an exquisite flower, around a circle.

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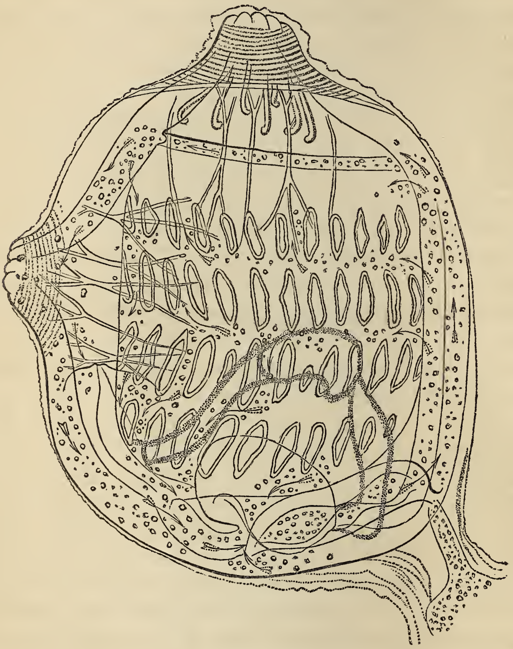
* Zool. Journ. iv. 172.

† Introduction to Conchology, p. 199.

In the *Tunicata*, examples of which may be found on our rocky beaches, closely adhering to the under surface of stones at low water, and looking like shapeless masses of a substance something between gristle and jelly,—the breathing organ is developed to a very great extent. It occupies a capacious chamber in the interior of the animal, the two sides of which are studded on their inner surfaces with little oval cells, arranged in a regular pattern of rows. Each of these cells is formed by an oval ring of *cilia*, which, when in full play, present a most beautiful and interesting spectacle. The accompanying figure, taken from the life, is a magnified representation of a tiny creature, not larger than a pin's head, but as transparent as the purest crystal. The oblong rings conspicuously seen are the ciliary cells of the breathing organ; but no figure can convey an adequate impression of the beauty of the sight, when the observer gazes upon forty or more of these ovals, all set round their interior with what look like the cogs on a watch-wheel, dark and distinct, running round and round with an even, moderately rapid, ceaseless motion.

One large tribe of the *Gasteropoda* comprises animals, however, which breathe air, and are terrestrial in their habits. Of these the Slugs and Snails of our fields and gardens afford familiar examples. The delicately-formed, and often brilliantly-painted shells, which throng the damp woods in tropical countries, likewise belong to this group, and furnish the most highly prized treasures of our conchological cabinets. In these the air is

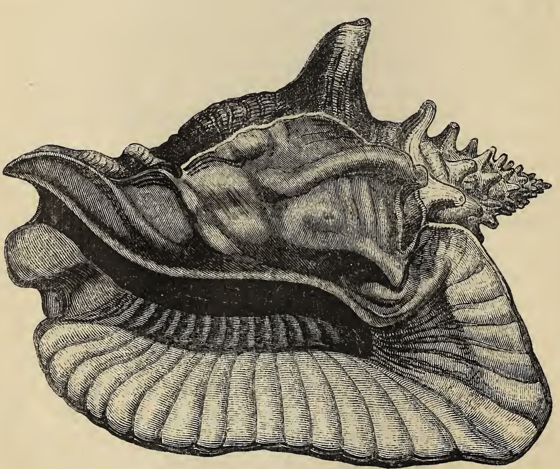


PEROPHORA.

inhaled into an ample chamber, the interior of which is lined with *cilia*. After parting with its oxygen, it is again expelled; the common orifice for both processes being situated on the side of the body. Any one may have ocular evidence of the existence of this organ, by watching our common Garden Snail. If you look at its right side, just behind the tentacle, or horn, that carries a black eye at its point, you will see a large hole suddenly open, where before there was no trace of it. After remaining open for a few moments, the margin will leisurely contract again, until it is perfectly closed, and as invisible as before. This is the breathing orifice; and during the interval that you saw it open, the aerial contents of the chamber were expelled, and a copious draught of fresh air was inspired. The process is repeated with tolerable regularity about once every fifteen seconds.

The blood in the MOLLUSCA is thin, transparent, and colourless; or at most presents only a pale bluish-white hue. It is, however, contained in a system of distinct vessels, through which it circulates, having for the source of its motion a well-developed, complex, pulsating heart.

Besides the system of vessels which carry the blood, there is another system, most conspicuous in the aquatic tribes, which has been called the *system of aqueducts*. They communicate with the element in which the animal lives and moves, and are filled with it at will, as the galleries and canals of a sponge are filled with the liquid in which it is immersed. The chief use of these water-canals appears to be the distension and expansion of the foot, to render it better fitted for locomotion, yet so as not to interfere with the privilege, essential to most of these animals, of withdrawing the whole of the body within a shell. Some of the marine Mollusca, when in a state of activity, protrude a soft foot, far exceeding in dimensions the whole bulk of the shell; yet let the creature be disturbed, and the whole is suddenly withdrawn into the cavity, so completely that not a trace of it is visible. "When shrunk within its shell," observes Dr. Johnston, "you might well deem any animal that could hide itself there, all too small and weak to carry about a burden larger and heavier than itself, and that safety might be here advantageously exchanged for relief from so much heaviness of armour, and from such an impediment to every journey. There is in my small cabinet a fine specimen of *Cassis tuberosa*, which measures fully ten inches in length, and upwards of eight in breadth, another of *Strombus gigas* is nearly one foot in



THE GIANT STROMBUS.

length. The weight of the former is four pounds two ounces; that of the latter, four pounds nine ounces; yet the snail creeps under this load at apparent ease. Nor are you much surprised when you see it actually in motion, for the seeming disproportion between the contained animal and containing shell has disappeared. On issuing from its shell, like an Eastern Genii freed from his exorcism, the animal has grown visibly,—has assumed a portlier size and more pedestrious figure. The body has suddenly become tumid and elastic, the skin and exterior organs stretched and displayed, the foot has grown in length and in breadth, and, with additional firmness, it has acquired at the same time the capability of being directed, bent, and modified in shape, to a considerable degree, as the surface of the road traversed may require. Thus it is with nearly all the cephalous mollusca; and by a similar disposition of aqueducts, the foot of the Bivalves is equally adapted to every act subservient to their locomotion and more especially to the act of burrowing; for had the foot not been so framed as to permit of an enlargement superior to the size of the shell, it seems obvious that the furrow could not have been made large enough to contain the latter. The same, too, with many Gasteropods which burrow in the sand when in search of prey. The *Buccina* and most carnivorous mollusca have this ability, dependent on the system of aqueducts we have been describing; and you must observe, that from the manner in which the shell is attached to the body by the large retractor muscle, it so happens that this is drawn into the furrow always with the notch in the aperture uppermost, so that, when completely buried, the animal is still enabled to communicate with the water by its respiratory siphon." *

Beyond the rudimentary strip of cartilage that in some of the *Cephalopoda* represents the vanishing spine of the VERTEBRATA, the MOLLUSCA have no internal skeleton. But in the great majority of cases, the soft parts are protected and supported by what we may call an external skeleton, of the substance familiar to us as *shell.* Lime is the essential element of this substance, as it is also of bone: but *shell* is a *carbonate* of lime, while the earthy part of bone is a *phosphate.*

When we consider the beauty and variety that are presented by shells, the important part they play in the economy and habits of the animals, and the use that is made of them in systematic arrangement, it becomes a question of high interest to inquire in what manner they are formed.

"The shells themselves are absolutely deprived of vitality, permeated by no vessels, and as incapable of expansion by any internal power as the rocks to which they are not uncommonly attached; so that the young naturalist is necessarily at a loss to conceive either the mode of their formation, or the origin of all the gaudy tints and external decorations that render them the ornaments of our cabinets.

"The simple apparatus by means of which shells are constructed, is the external membranous layer that invests the body of the mollusk,—the mantle, as it has been termed; and, whatever the form of the shell, it owes its origin entirely to this delicate organ. . . . .

"It is the circumference, or thickened margin of the mantle alone which provides for the increase of the shell in superficial extent. On examining this part, it is found to be of a glandular character, and moreover not unfrequently provided with a delicate and highly sensitive fringe of minute tentacula. Considered more attentively, it is seen to contain in its substance patches of different colours, corresponding both in tint and relative position with those that decorate the exterior of the shell.

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* Introduction to Conchology, p. 173.

"When the animal is engaged in increasing the dimensions of its abode, the margin of the mantle is protruded, and firmly adherent all round to the circumference of the valve with which it corresponds. Thus circumstanced, it secretes calcareous matter, and deposits it in a soft state upon the extreme edge of the shell, where the secretion hardens and becomes converted into a layer of solid testaceous substance. At intervals this process is repeated, and every newly-formed layer enlarges the diameter of the valve. The concentric strata thus deposited remain distinguishable externally, and thus the lines of growth marking the progressive increase of size may easily he traced.

"It appears that at certain times the deposition of calcareous substance from the fringed circumference of the mantle is much more abundant than at others: in this case ridges are formed at distinct intervals; or, if the border of the mantle at such periods shoots out beyond its usual position, broad plates of shell, or spines of different lengths, are secreted, which, remaining permanent, indicate, by the interspaces separating successively deposited growths of this description, the periodical stimulus to increased action that caused their formation.

"Whatever thickness the shell may subsequently attain, the external surface is thus exclusively composed of layers deposited in succession by the margin of the mantle, and, seeing that this is the case, nothing is more easy than to understand how the colours seen upon the exterior of the shell are deposited, and assume that definite arrangement characteristic of the species. We have already said that the border of the mantle contains, in its substance, coloured spots: these, when minutely examined, are found to be of a glandular character, and to owe their peculiar colours to a pigment secreted by themselves; the pigment so furnished being therefore mixed up with the calcareous matter at the time of its deposition, coloured lines are found upon the exterior of the shell wherever these glandular organs exist. If the deposition of colour from the glands be kept up without remission during the enlargement of the shell, the lines upon its surface are continuous and unbroken; but if the pigment be furnished only at intervals, spots or coloured patches of regular form, and gradually increasing in size with the growth of the mantle, recur in a longitudinal series wherever the paint-secreting glands are met with. . . . .

"While the margin of the mantle is thus the sole agent in enlarging the *circumference* of the shell, its growth in *thickness* is accomplished by a secretion of a kind of calcareous varnish, derived from the external surface of the mantle generally; which, being deposited layer by layer over the whole interior of the previously existing shell, progressively adds to its weight and solidity. There is, moreover, a remarkable difference between the character of the material secreted by the marginal fringe, and that furnished by the general surface of the pallial membrane; the former we have found to be more or less covered by glands appointed for the purpose, situated in the circumference of the mantle, but as these glands do not exist elsewhere, no colouring matter is ever mixed with the layers that increase the thickness of the shell, so that the latter always remain of a delicate white hue, and form the well-known iridescent material usually distinguished by the name of *nacre*, or *mother of pearl.*" *

This lucid description of the process specifically applies to the *Conchifera*, or Bivalves; but the formation of the shell in the *Gasteropoda* is not marked by any important point of difference.

No species of this great Division of animals is furnished with *limbs*, properly so called: unless we may consider as such the long flexible tentacular arms of the Poulpes and Cuttles (*Cephalopoda*) which are used as instruments of an ungainly sort of crawling, as well as for seizing prey and dragging it to the mouth: yet various modes of locomotion are by turns practised among the MOLLUSCA. In one extensive Class, the *Gasteropoda*, of which the Limpet and the Snail are examples, an even gliding movement is that which is most characteristic; a broad expanded muscular disk, called the foot, being applied to the surface over which the animal crawls. Many of the aquatic members of the Class are able to float at the surface by the aid of the same organ. They crawl to the top of the water up the stem of a plant, or the side of a rock, and stretching out the bottom of the foot along the surface, *the back being downward*, it presently dries by contact with the air. While it remains dry, it will float the animal, which then glides along as if on a solid body, *crawling*, in fact, *on the inferior surface of the air:* but if by any agitation of the water, or by the will of the animal, the foot become overflowed, the state of suspension is ended, and the creature falls to the bottom. The Pond-snails (*Limneus*), with olive-coloured fragile shells, that inhabit every little pool and lakelet, may be seen in a summer's day, by scores, enjoying the air in this manner.

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* Jones's Animal Kingdom, p. 385.

POULPE AND CALAMARY.

The wide ocean between the tropics is inhabited by a shell, resembling in appearance that of a Snail, but tinged with blue (*Ianthina*), which is furnished with an elaborate apparatus for swimming,—

> "Like little wanton boys that swim on bladders."

To the hinder part of the foot is attached a kind of float, consisting of many small bladders of thin membrane, united in a group, and looking somewhat like coarse froth. By means of these, the shell floats securely on the broad sea.

Another bladder-swimmer, and like the former, an ocean-species, is the *Litiopa.* "This is a small snail, born amid the gulf-weed, where it is destined to pass the whole of its life. The foot, though rather narrow and short, is of the usual character, and, having no extra hold, the snail is apt to be swept off its weed; but the accident is provided against, for the creature, like a spider, spins a thread of the viscous fluid that exudes from the foot, to check its downward fall, and enable it to regain the pristine site. But suppose the shock has severed their connexion, or that the Litiopa finds it necessary to remove, from a deficiency of food, to a richer pasture, the thread is still made available to recovery or removal. In its fall, accidental or purposed, an air-bubble is emitted, probably from the branchial cavity, which rises slowly through the water, and as the snail has enveloped it with his slime, this is drawn out into threads as the bubble ascends; and now, having a buoy and bladder whereon to climb to the surface, it waits suspended until that bubble comes into contact with the weeds that everywhere float around." *

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* Johnston's Conchology, p. 134.

A species of *Cerithium*, found at the mouths of rivers in tropical countries, has the silkworm-like habit of spinning threads, by which it suspends itself from the mangrove-roots; and our own freshwater Snails have the power of suspending themselves in the same manner. Mr. Warington, in an interesting paper on the habits of some aquatic animals kept in confinement, thus records the curious fact:—

LIMNEUS AURICULARIS.

"In watching the movements of the *Limnei*, I was for some time under the impression that they had a power of swimming or sustaining themselves in the water, as they would rise from the bottom of the pond, a portion of the rock-work, or a leaf of the plants, and float for a considerable period, nearly out of their shells, without any apparent attachment, and by the contortions and gyrations of their body and shell, move some little distance, in a horizontal direction, from the point which they had left. On more carefully watching this phenomenon, however, I found they were attached by a thread or web, which was so transparent as to be altogether invisible, and which they could elongate in a similar way to the spider: they also possessed the power of returning upon this thread by gathering it up, as it were, and thus drawing themselves back to the point which they had quitted. These facts were clearly proved in the following manner: A *Limneus stagnalis* had glided its way along a young and short leaf of the *Vallisneria*, which terminated below the surface of the water, and having reached the extremity, launched itself off from it; after moving about with a sort of swimming or rolling motion in a horizontal direction for some time it lowered itself gradually, and in effecting this, the long flexible leaf of the *Vallisneria* was bent with an undulating motion, corresponding exactly with every movement of the snail, clearly showing that it had a firm attachment to the extremity of the leaf. On another occasion a *L. glutinosus* gradually rose from the surface of a piece of submerged rock, and when at the distance of about three or four inches from it, stayed its progress, floating about in a circumscribed horizontal direction for some time; at last it rose suddenly and rapidly to the surface, evidently from the rupture of its thread of attachment. The most convincing proof, however, of this fact, that I can, perhaps, adduce, and one that I have often repeated with all the before-mentioned *Limnei*, is that when the snail has been some inches distant from the supposed point of attachment, a rod or stick has been carefully introduced, and slowly drawn on one side between them in a horizontal direction, and by this means the snail can be made to undulate to and fro, obeying exactly the movement of the rod: this requires to be done very gently, as, if too much force is used, the web is broken, and the snail rises rapidly to the surface." *

The wide expanse of ocean from the equator to the poles is tenanted by a class of swimmers, small, indeed, in the number of its species, but countless in the hosts of individuals of which they are composed; the *Pteropoda*. Some of these inhabit shells, which for delicacy and transparency, excel the thinnest glass. They possess a pair of large membranous fins, which closely resemble the wings of a butterfly, and by using these organs in a flapping manner, the little animals swim briskly about.

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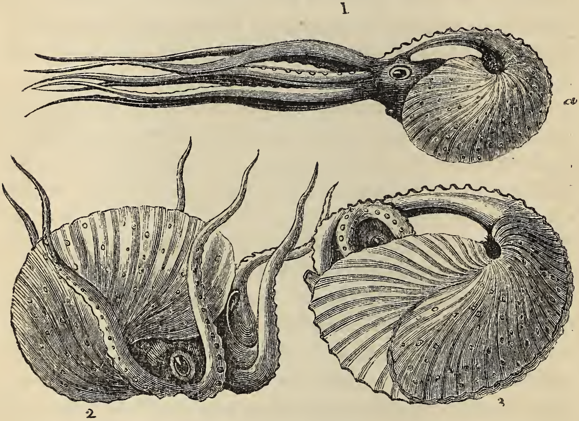
* Annals of Natural History. October, 1852.

Perhaps some of my readers will expect me to include the beautiful Paper Nautilus (*Argonauta*), among swimming Mollusks; seeing that the poets have claimed for it the honour of teaching navigation to man:—



PAPER NAUTILUS.

> "Learn of the little Nautilus to sail,
> Spread the thin oar, and catch the rising gale."—Pope.

Montgomery, the poet of the ocean, thus beautifully expresses the popular notions concerning it:—

"Light as a flake of foam upon the wind,
Keel upward from the deep, emerged a shell,
Shaped like the moon ere half her horn is fill'd;
Fraught with young life, it righted as it rose,
And moved at will along the yielding water.
The native pilot of this little bark
Put out a tier of oars on either side,
Spread to the wafting breeze a twofold sail,
And mounted up, and glided down the billow,
In happy freedom, pleased to feel the air,
And wander in the luxury of light."—PÉLICAN ISLAND.

The accuracy of modern research, however, has proved this to be but a pleasant fable. The Argonaut is a Cuttle-fish, and crawls along the bottom, like its fellows, by means of its slender, flexible, tentacular arms, as represented in the preceding engraving, (fig. 2); while the pair that are furnished with a broad fleshy disk, have an office very different from that of sails, namely, that of forming, repairing, and protecting the thin and papery shell. (See fig. 3.) Its only swimming power appears to be that which it possesses in common with all *Cephalopoda*, of shooting along in a backward direction, by the force of a jet of water from the funnel, as shown at fig. 1, where it is represented as swimming towards the point *a*.

Among the TUNICATA there are some singular tribes which swim freely in the sea. "The *Salpæ*, translucent as their native waters, and often united in chains, after a pattern peculiar to each species, are driven along the surface with considerable quickness by alternate contractions and expansions, and by the propulsion they receive from a current of water, which is made continually to traverse the long diameter of the body, sucked in by the posterior aperture, and issuing in a stream through that on the side of the mouth. Hence the body is always pushed backwards — a circumstance that has misled some naturalists to describe the posterior aperture for the true mouth. The *Pyrosomata* are a still more singular family of the same order. Each seeming individual of this genus is, in fact, a numerous colony of little mollusca, every one in its own cell, distinct, yet inseparably connected with its fellows. Collected into the figure of a gelatinous cylinder, open at one extremity and closed at the other, and roughened externally by a multitude of tubercles disposed sometimes in rings and sometimes irregularly, they float in the Australian seas like stars of this lower world, shedding around them a halo of light, brilliant indeed, but surpassed in beauty by those other colours of the creatures which it serves to disclose; colours which come and go at pleasure, glorying as it were, in their subtle changes, passing rapidly from a lively red to aurora, to orange, to green, and to azure blue; a magic scene, compelling more than the admiration of every beholder." *

Bivalve Mollusca in general have much less power of shifting their locality than Univalves. Many appear to be absolutely stationary, at least during their adult existence. But others, as the Cockle, have a most versatile organ, known as the foot, capable of being protruded from between the valves, which, among its various uses, serves the purpose of locomotion. It is in general applied in this manner. Being stretched out to its utmost extent, its point is made to hook downward into the sand or mud, and the body with the shell is then dragged down by the muscular contraction of the foot. In most cases, this mode of progression is sufficiently slow and awkward, but some of the sand-borers are able to conceal themselves thus with surprising rapidity.

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* Johnston's Intr. to Conch. p. 125.

Others of this Class are vigorous leapers; and of some the bounds are so vivacious, forcible and sudden, that they might almost be compared with the flight of a bird, or the shooting of a fish. The Clams or Scallops (*Pecten*) and their elegant relatives the *Limæ*, are eminent among our native species for this faculty. The mode in which the leaps are effected is always described as being the opening and sudden closing of the valves or shells; but, in the case of the former genus, I have recently found that the real organ of motion is the mantle. The edges of this being firmly closed, when the interior is filled with water, the fluid is forcibly ejected from the lips, which are relaxed for the purpose at any point according to the will of the Scallop; and by the jet of water striking on the surrounding element, the whole animal is shot to a considerable distance in the opposite direction.

Most of the MOLLUSCA are, as I have already intimated, inhabitants of the waters, and these are divided between the seas and the freshwaters, in a ratio somewhat like that which these divisions of the waters of our globe bear to each other. Of the marine kinds some dwell permanently and exclusively at the bottom of the deep sea, whence they are to be procured only by dredging. A species of *Crania* has been brought up from a depth of 255 fathoms. Others inhabit the open ocean, habitually or occasionally swimming on the top of the waves, or resting on the floating sea-weeds of warm latitudes. Many species confine themselves to the vicinity of the shore, where each peculiar situation and locality has its proper kinds. The sands, the ooze and mud of harbours, the boulders and loose stones of the wave-washed beach, the sides, ledges, and pools of rocks, uncovered at the recess of every tide, are all inhabited by species peculiar to the respective locality. Some species strictly marine are able to endure protracted exposure to the air, as the Periwinkle and the Limpet, the most familiar of shell-fish, which every visitor to the sea-side habitually sees clustered on the rocks close to the limits of high-water mark.

The fresh-water Mollusca manifest a similar choice of situation, though a less latitude is permitted for its exercise. Some are peculiar to large rivers, some to estuaries, others to lakes, and yet others to small ponds and ditches.

In general the habits of one species of a genus when ascertained, are found to indicate those of all its fellows of the same genus; as for instance not only is our common Cockle (*Cardium edule*) a burrower in the ooze at the margin of the sea, but all other species of the genus *Cardium* have similar habits of life. Yet Mr. Gray has enumerated a considerable catalogue of species, which break this rule, classing them under four divisions. 1st, where species of the same genus are found in more than one kind of situation, as on land, in fresh and in salt-water; 2nd, where one or more species of a genus, most of whose species inhabit fresh-water, are found in salt or brackish water; 3rd, where, on the contrary, one or more species of a genus, whose species generally inhabit the sea, are found in fresh-water; and 4th, where the same species is found both in salt and fresh-water." *

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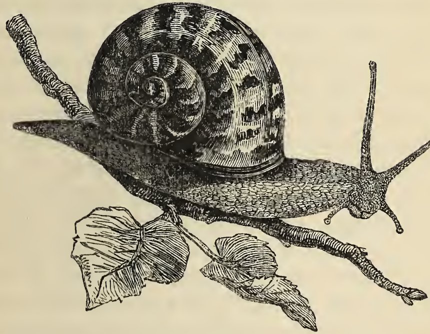
* Philos. Trans. 1835; Part ii.

Of those species which dwell upon the land and breathe the air, most affect moist situations. The common Garden Snail, as is well known, retires to crevices and corners in continued dry weather, where it closes its shell with a temporary door to prevent the evaporation of its vital juices, and patiently waits the return of congenial humidity. The first shower prompts the sensitive creatures to venture abroad, and we see them crawling by dozens over our borders and garden walks, imbibing from the steaming surface the grateful moisture. The damp woods of warm countries are the situations which most reward the researches of the laborious collector of land-shells; but there are some which are found in the driest places, as stony plains, and the summits of arid hills.



GARDEN SNAIL.

Many terrestrial Mollusca which ordinarily inhabit moist places, are enabled, by a precaution similar to that adopted by our own Snail in drought, to sustain life, in such a state of retirement and suspension of their usual habits, not for a few days or weeks only, but even for many years. Numerous examples have occurred in which the land-shells of distant countries have been brought to England, alive but torpid, and have been kept shut up in drawers for twelve, eighteen, and even twenty months; manifesting no signs of life until moistened, when they presently crawled about, and began to eat. But the most singular example of this protracted sleep on record, is that of Mr. Simon's Snails, which must surely have been the veriest Rip Van Winkles among Mollusca. The following account is from the Philosophical Transactions; and the facts seem to have been carefully investigated, and well authenticated:—

"Mr. Stuckey Simon, a merchant of Dublin, whose father, a fellow of the Royal Society, and a lover of natural history, left to him a small collection of fossils and other curiosities, had among them the shells of some snails. About fifteen years after his father's death (in whose possession they continued many years), he by chance gave to his son, a child about ten years old, some of these snail-shells to play with. The boy put them into a flower-pot, which he filled with water, and the next day into a basin. Having occasion to use this, Mr. Simon observed that the animals had come out of their shells. He examined the child, who assured him that they were the same he had given him, and said he had also a few more, which he brought. Mr. Simon put one of these into water, and in an hour and a half after, observed, that it had put out its horns and body, which it moved but slowly, probably from weakness. Major

Vallancy and Dr. Span were afterwards present, and saw one of the snails crawl out, the others being dead, most probably from their having remained some days in the water. Dr. Quin and Dr. Rutty also examined the living snail several different times, and were greatly pleased to see him come out of his solitary habitation after so many years' confinement. Dr. Macbride and a party of gentlemen at his house, were also witnesses of this surprising phenomenon. Dr. Macbride has thus mentioned the circumstance:—'After the shell had lain ten minutes in a glass of water that had the cold barely taken off, the snail began to appear, and in five minutes more we perceived half the body pushed out from the cavity of the shell. We then removed it into a basin, that the snail might have more scope than it had in the glass; and here, in a very short time, we saw it get above the surface of the water, and crawl up towards the edge of the basin. While it was thus moving about, with its horns erect, a fly chanced to be hovering near, and, perceiving the snail, darted down upon it. The little animal instantly withdrew itself into the shell, but as quickly came forth again, when it found the enemy had gone off. We allowed it to wander about the basin for upwards of an hour, when we returned it into a wide-mouthed phial, where Mr. Simon had lately been used to keep it. He presented me with this remarkable shell, and I observed, at twelve o'clock, as I was going to bed, that the snail was still in motion; but next morning I found it in a torpid state, sticking to the side of the glass." *

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* Phil. Trans. (abridged) xiii. 566.

In treating of the food of the Mollusca, Dr. Johnston divides them into three classes; first, those which take their food in a liquid form, or suspended in water; secondly, those which are more properly carnivorous; and, thirdly, those which feed on vegetable matter.

Under the first division are comprised all those which have no distinct head, including the three classes, *Tunicata*, *Brachiopoda*, and *Conchifera*. None of these have any power of pursuing prey, nor any organs for mastication. Yet any one who has ever examined with a microscope, either the sea-water, which appears to the naked eye pure and simple, or the impalpable sediment which lies upon the bottom, will be at no loss to discover abundant organic matter fitted to supply nutriment to these headless, generally stationary, and apparently helpless creatures. Countless millions of Infusorial animalcules sport in the clear water, altogether unappreciable by our senses, while vegetables clothed with flinty shells, the *Diatomaceæ* of botanists, equally numerous and equally minute, crowd the mud on the floor of the sea.

In order that these minute bodies should afford nutriment to the headless Mollusca, a simple but effective contrivance is provided. The currents which ceaselessly play over the breathing organs, produced by the cilia which cover them, not only bring water to be respired, but come charged with the various organic particles, both animal and vegetable, that occur in the vicinity. It is, therefore, merely necessary that the orifice of the stomach, which for convenience sake may be called the mouth, be situated in the course of the currents, and be endowed with the power of selecting and retaining such substances as are suitable for digestion.

The remaining classes divide themselves into flesh-eaters, and those which live upon vegetable diet, the preponderance, however, being, as well as can be estimated, rather with the former. Not a few of the Univalves feed upon their Bivalve relatives, not seizing the opportunity, as has been pretended, of killing their victim as it lies incautiously with gaping shells; but by drilling a small hole through one of the valves, and extracting the fleshy parts, particle by particle. Some species devour dead fishes and other putrifying animal matters with avidity. Many of the elegant naked-gilled tribes prey on each other, though their proper food consists of zoophytes. I have found the large *Eolis papillosa* tear away the tentacles of different species of sea-anemones, which seemed to be its natural food.

The *Cephalopoda*, including the Cuttles, the Poulpes, and the Squids, are fierce and predatory, the tyrants of the deep. Furnished with many long arms, stretching in all directions, and studded with rows of adhesive suckers, they seize with ruthless grasp any passing fish or other animal, whose strength is inferior to their own, and drag it to a hard and sharp horny beak, the mandibles of which resemble those of a parrot's bill, and being moved by powerful muscles are enabled either to crush the shells in which their victim may be enclosed, or to tear it to pieces if it be a fish, or other animal of muscular or sinewy tissues.

In speaking of the vegetable-feeding Mollusca, the ravages committed by those pests of our gardens, the Slug and Snail, will occur to every one. Other species of the same genera are never or rarely seen in gardens, but devour the herbage of the roadside, the bank, or the hedge. Many, particularly those which inhabit the woods of foreign countries, devour the leaves of trees. The plant-eaters among the marine tribes live upon the various kinds of sea-weeds, of which there is a sufficient variety to gratify a taste much more epicurean than it probably is in reality. The common Periwinkle and the Limpet are both vegetable feeders, and there is a pretty little species of the latter genus which invariably, I believe, confines itself to one plant: this is the *Patella pellucida,* distinguished by having on its summit three or four lines of blue, most brilliantly gemmeous. It feeds on the tangle, (*Laminaria digitata*) eating away a cavity for itself, just large enough to contain its body, in the substance of the cartilaginous stem, commonly beneath the shelter of the arching roots. I have pulled up the tangles by dozens at low spring-tide, and have scarcely ever found one that had attained certain dimensions without finding a little parasitical Limpet embedded in its substance.

If we measure the interest which we take in any section of created beings by their powers of conferring benefit or inflicting injury on our own race, we shall find the Mollusca not unworthy of our regard in both these respects. Many of them are used as human food, and that not by savage nations only, but by ourselves and by all classes of society. The Limpet, the Periwinkle, the Whelk, the Mussel, and the Cockle, are commonly sold in the streets of our sea-port towns and large cities, though these are certainly more prized by the lower classes of society than by those of more cultivated tastes.

There is no doubt that many if not all of our larger Bivalves might be added to the list, and probably some of these might prove not unworthy of a place among more delicate viands. I have myself tried the large *Pholas dactylus*, that bores the sandstone, and have found its substance tender, and its taste agreeable.

The Cuttle-fishes, though but little used among ourselves, are prized by most other nations. Mr. Couch, speaking of the common Squid, declares that it is excellent, and compares it to tripe, a resemblance to which the kindred genus owes its name, for Kuttel in German signifies tripe. Among the people of Southern Europe the Cuttles are in high repute for the table, and this taste has been

PHOLAS.

handed down from the ancient Greeks and Romans. The classics frequently allude to them as among the greatest delicacies. At the nuptial feast of Iphicrates a hundred *Polypi* and *Sepiæ* were served up. Among the Greeks generally they were disguised with various condiments and sauces; and the Poulpe, or Many-feet, (*Polypus*, the *Octopus* of modern zoology) was the most highly esteemed. Dr. Johnston quotes the "good old story" of Philoxenus in illustration of the gourmand taste for this ill-looking *Cephalopod.*

> "Of all fish-eaters,
> None, sure, excell'd the Lyric bard, Philoxenus.
> 'Twas a prodigious twist! At Syracuse,
> Fate threw him on the fish call'd 'Many-feet.'
> He purchased it, and drest it; and the whole,
> Bate me the head, form'd but a single swallow.
> A crudity ensued—the doctor came,
> And the first glance inform'd him things went wrong.
> And 'Friend,' quoth he, 'if thou hast aught to set
> In order, to it straight;—pass but seven hours,
> And thou and life must take a long farewell.'
> 'I've nought to do,' replied the bard, 'all's right
> And tight about me. . . . .
> . . . . . . I were loath, howe'er,
> To troop with less than all my gear about me;—
> Good doctor, be my helper then to what
> Remains of that same blessed Many-feet.'"

Snails appear to have found equal favour with the ancients. The Romans were accustomed to keep these animals in snail-sties, or *Cochlearia*, where they fattened them with nutritive pastes artificially made. The species was probably the *Helix pomatia*, which is considerably larger than our garden snail, but the dimensions which they are said to have attained under these favourable circumstances are so enormous as to be utterly incredible. The Illyrian snails were most esteemed for their size, and Pliny informs us that it was a matter of emulation among the amateur snail-feeders of that day to excel each other in the bulk to which their pets should attain; vaunting their most prodigious specimens, as prize pigs and oxen are boasted of among ourselves: "And in time men grew to take such a pride and glory in this artificial feat, namely, in striving who should have the biggest, that in the end one of their shells ordinarily would contain eighty measures called quadrants."*

Our continental neighbours still enjoy a dish of snails, and several attempts have been, from time to time, made to introduce them at English tables, but with very little success.

But among all the edible Mollusca, there is none that can compete with the Oyster. To speak of the universality of the esteem would be superfluous; but some statistical particulars may not be uninteresting, as showing the importance of this shell-fish in a commercial view. "The number of vessels immediately employed in the dredging for oysters on the Essex coast are about 200, from twelve to forty or fifty tons burden each, employing from 400 to 500 men and boys. The quantity of oysters bred, and taken, and consumed annually, mostly in London, is supposed to amount to 14,000 or 15,000 bushels. All the fisheries connected with this part of the coast, are stated to employ a capital supposed to amount to from £60,000 to £80,000."†

It is, however, not only as supplying food that the benefits of the Mollusca are to be estimated: they are useful also in the arts. The pearl, that splendid auxiliary to costume in all ages, glittering on the tiara of the Assyrian monarchs and on the diadem of our own sovereign, is a production of this class of animals, This, it is true, has no merit beyond its beauty, but the substance called mother-of-pearl is, as is well known, much used in the arts. It consists of the interior layers of many species of shells, principally Bivalves; but some among the Univalves have an interior brilliantly nacreous. The Top-shells (*Trochus*), several species of which

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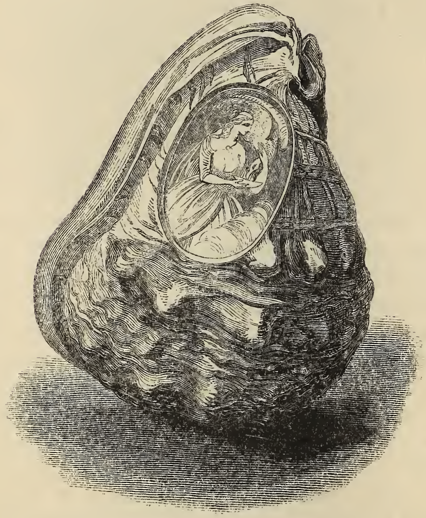
* Holland's Pliny, vol. i. p. 267.

† Encyc. Brit. Supp. vol. iv. p. 269.



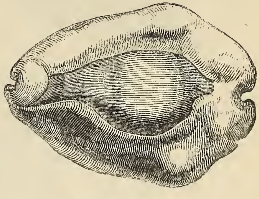
CAMEO CUT IN A CASSIS.

occur on our own shores, are very rich in this respect, and the widely-gaping Ear-shells (*Haliotis*) are most gorgeous.

The elegant articles called cameos, so much used as clasps and brooches, are formed out of the substance of large shells: the ponderous Helmets (*Cassis*) of the West Indies are chiefly used for this purpose. A great excellence in the art consists in the careful cutting away of the material so that the ground shall display one colour, commonly a dark hue, while the design is carved in another, commonly the pure white, which overlays the brown.

Shells, being composed of carbonate of lime, are capable of being burned to a quick-lime, having all the essential properties of that made from stone. On some parts of our own shores where limestone is scarce, shell-lime is extensively burned; but in other countries, as Holland and the United States of America, scarcely any other is used, either for building purposes or for manuring land.

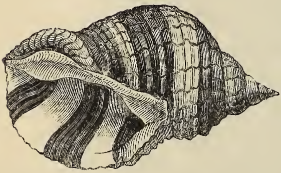
Among the subordinate uses of shells may be mentioned that in China and Japan the valves of a sort of Oyster (*Placuna*), which are as large as a plate, flat, and transparent, are used in windows and for other purposes where we employ glass; and among the semi-barbarous nations of Africa, a little species of Cowry (*Cypræa moneta*) is universally recognised as a money currency.



MONEY COWRY.

The natural secretions of the Mollusca are not much used among us. The Indian ink used by artists is generally understood to be in part, at least, composed of the black liquor of some species of Cuttle; and an ink is prepared in Italy from this liquor, which, according to Cuvier, differs from the genuine China ink only in being a little less black. Among the ancients this secretion was certainly the basis of the ordinary writing ink, and the soft blackish-brown colour, known as sepia, is at this day manufactured from it.

The Tyrian purple, the most celebrated manufacture of that famous crowning city whose merchants were princes, was the juice of a shell-fish. Several species were employed to communicate various tints, but the principal was the *Murex trunculus*, one of the commonest shells of the Mediterranean, which may be compared for size and general appearance to our familiar Whelk. But there is a shell occurring by myriads on our own rocky shores, which has a like property; it is the *Purpura lapillus*, a small white univalve, surrounded by one or more bands of brown more or less distinct. I have myself been entertained with making experiments on the purple dye of this shell-fish, which, perhaps, some of my readers may like to imitate. In order to this, having collected a few of the animals, which adhere to the rocks between tide-marks, break the shells with the blow of a hammer, taking care not to crush the animals: throw them then into a basin of fresh water, in which they will die in a few minutes. Examining them now, you will find, just behind the head, under the overlapping edge of the



PURPURA.

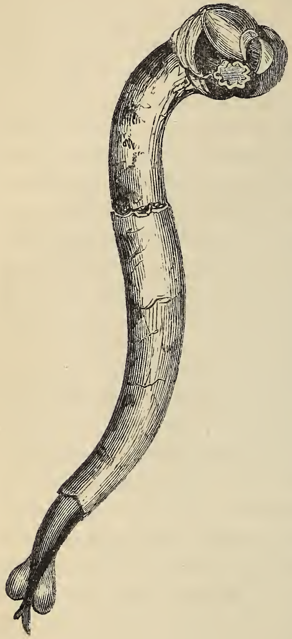
mantle, a thick vein of a yellowish white hue, filled with a substance resembling cream: this is the dye in question. It is thick and glutinous, so that you cannot well apply it with a pen; but with a camel's-hair pencil you may paint, as it were, upon linen or cotton cloth any lines, the initials of your name, for example. When you have done this you will perhaps be disappointed, for the marks as they dry will be but just discernible, displaying only a pale yellow tint with not the slightest approach to purple, but exhaling an insufferable odour of garlic.

Place your linen in the light of the sun, and look at it again in half-an-hour, or, if you please, watch its changes. The marks have by this time passed from yellow into pea-green, and are now of a full grass-green; under the influence of the light the change proceeds rapidly, the yellow element gradually disappearing, and the blue element becoming more and more prominent, until through the stages of deep-green, sea-green, and greenish-blue, the colour at length appears a full indigo. The red element now begins to be apparent, and rapidly increases in intensity until the hue is a dull, reddish purple. In my own experiments this was the ultimate tint obtained; a tint perfectly indelible as long as the texture of the material remained, neither light, nor time, nor washing, nor the application of chemical agents having now the least influence either in changing its hue or causing it to fade. I have seen it stated that if the cloth be washed in scalding water and soap, it comes out from the lather changed from the reddish purple hue to a fair bright crimson; with me, however, the soap and the hot water had no appreciable influence in brightening the colour. My experiments were performed in winter, and I will not affirm that the intensity of a summer's sun would not in some degree have modified the result. There appears to me one objection to this material ever having been used to dye large surfaces of uniform colour; for from the admixture of mucus with the colouring matter, when any quantity of the latter is collected, the hue is found to imbue the cloth in a mottled or blotched manner, some parts being much darker than others. What method the ancients had of avoiding this appearance I do not know.

I have seen it repeatedly stated that the slimy liquor remaining in the shell of the common snail, when the animal is crushed, is an admirable cement for glass or china, resisting both heat and moisture. I have tried it both simple, and mixed, as sometimes directed, with quick-lime in powder, but am compelled to confess, that I found it utterly worthless, the adhesion being in every case no greater than if I had used spittle for the purpose.

Let us now see what rank the Mollusca can assume among those creatures which inflict direct injury upon man. The ravages committed by various species of snails and slugs are often annoying, and sometimes serious. There are probably few of my gentle readers who have a garden at their disposal, who have not been disappointed of their crops of spring flowers by the nightly depredations of these pests. The border has been well dug and smoothed, the seed has been carefully sown, and the spot has been eagerly watched from day to day; but no sooner have the tender seed-leaves appeared above ground in a slender green line or circle, than night after night they are gnawed away, until nothing remains but the brown earth, and the label which tells where the seed had been. But to the farmer the consequences are often much more important. In wet seasons the slugs increase with such rapidity in the fields, that a wheat-crop after one of clover, tares, or beans, is very uncertain, and may be said generally to fail. The damage annually done to corn, clover, and turnips, by these apparently insignificant creatures, is very great. In France and the South of Europe, the vineyards are subject to similar attacks from the vine snail (*Helix pomatia*). The buds and opening leaves of the vine are gnawed off by them as they appear, and the hopes of the autumnal vintage are often blasted.

But much more lamentable than any of these are the injuries inflicted upon shipping, and the piers and defences of maritime towns, by the ship-worm (*Teredo navalis*). Ranging over extensive seas from the tropics to the shores of Northern Europe, this boring worm, or rather Mollusk with a worm-like form, is incessantly engaged in devouring and destroying all kinds of woodwork that is immersed in the sea. Linnæus long ago styled it the calamity of ships, and there is no maritime nation which has not confessed the formidable power of this subtle enemy. In the years 1731 and 1732, the United Provinces were under a dreadful alarm; for it was discovered that these mollusks had made such depredations on the piles which support the banks of Zealand and Freisland, as to threaten them with total destruction, reclaiming from man what he had with unexampled labour wrested from the ocean. A few



TEREDO.

years after they fortunately abandoned the dikes; but fearful of the return of an enemy more powerful than even the Grand Turk, who boasted that he would exterminate them with a host armed with spades and shovels, the Dutch offered a reward of value, to any one who should discover a remedy to ward off their attacks, and ointments, varnishes, and poisonous liquors, were recommended by the hundred. The exact amount of the damage done at this visitation—which Sellius, unable to discover any natural cause for it, says was sent by the Deity to punish the growing pride of the Hollanders—I have not been able to ascertain. Writers in general speak of it as "very great;" and Dr. Job Baster mentions the Teredo as an animal "which has done so many millions damage to these countries." In our own country it has done, and continues to do, extensive mischief. The soundest and hardest oak cannot resist these noxious creatures; but in the course of four or five years, they will so drill it as to render its removal necessary, as has repeatedly happened in the dockyard of Plymouth. To preserve the timbers used there, and exposed to them, the plan now adopted is to cover the parts under water with short broad-headed nails, which, in salt water, soon invests the whole with a strong coating of rust impenetrable by their augers. The plan appears to have proved effectual, for, in the harbours of Plymouth and Falmouth, where the Teredo was once abundant, it is now rare or not to be found; but in other parts it has still a residence, and within these few years it has materially injured or destroyed many of the piles used in the construction of the pier at Port Patrick, on the coast of Ayrshire; and the *Limnoria terebrans*, a crustaceous insect, co-operating with it, the result of their united efforts can hardly fail to be the utter and speedy destruction of all the timber in the pier." *

Another kind of injury is dependent on the fact that certain species, which are generally eatable and even wholesome, become at certain times highly poisonous. Some foreign species are liable to this fatality, particularly oysters, both in the East and West Indies. But we need not go to distant countries for cases in point. The Mussels of our own rocks, though generally sold and eaten by many persons without fear, are well known to be fickle in their qualities, and many cases are on record in which their use has proved fatal. One of these, well authenticated, and investigated by scientific medical men, occurred at Leith in June 1827. Many of the poor of this town were poisoned by eating mussels which had been collected in the docks.

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* Introduction to Conchology, p. 11.

"The town," says Dr. Combe, "was in a ferment, and the magistrates with great propriety issued a warning against the use of the mussels. Many deaths were reported, and hundreds of individuals were stated to be suffering under the effects of the poison. Luckily, matters were not so deplorable; but we ascertained that in addition to the man mentioned before, the companion of our patient, an elderly woman, had died. In all about thirty cases occurred, with great uniformity of symptoms, but varying very much in severity; but none, so far as I know, have left any permanent bad effects."*

MUSSELS.

The cause of this occasional liability to become poisonous seems involved in almost total obscurity. Dr. Johnston, who discusses at some length the many loose and vague conjectures that have been hazarded on the subject, has shown, that not one of them is tenable, unless it be that in some cases the poisonous principle proceeds from some particular food which, not fatal to the Mollusks, yet gene-

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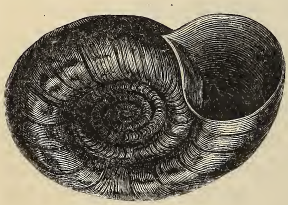
[*] Edin. Med. and Surg. Journal, xxix. p. 88.

rates a diseased condition of the body, deadly to other creatures. The Leith mussels, he adds, were living in a dock, where we may presume they were nurtured and fattened amid putrescent matters; and Dr. Coldstream, than whom no one is better qualified to decide the point, gave it as his opinion that the liver was larger, darker, and more brittle than in the wholesome fish, and satisfied Dr. Christison that there was a difference of the kind. It must be confessed, however, that these observations leave the question pretty nearly where it was before.

Some peculiar secretions of the Mollusca remain to be noticed. And first the black liquor or ink of the Cuttles and Squids, which has already been mentioned as useful to man, but which is doubtless much more useful to the animals themselves. These animals, when in danger, are known to pour forth from a funnel-like orifice a liquor of a blackish-brown colour in considerable abundance; this fluid, readily diffusing itself and mingling with the surrounding water, produces such a cloud of obscurity as frequently enables the crafty animal to escape, enveloped in the mist of its own making,—as the deities in Homer are represented as concealing their favourite heroes.

Somewhat analogous to this is a secretion of a rich purple hue produced and poured forth under excitement, by those large and naked mollusks, the *Aplysiæ.* I have found one of these animals, on being put into a vessel of clean sea-water, change the whole to a brilliant purple in a very few minutes; and on the water being renewed even again and again, produce the same result. This was a West Indian species, but there is one found occasionally upon our own coasts which has the same property. This liquor must not be confounded with that which constitutes the purple dye of *Murex*, *Purpura*, &c. already mentioned, for it is so volatile as to be unsuitable for the purposes of dyeing. According to Cuvier, the secretion in drying assumes the beautiful deep hue of the sweet Scabious, and remains unaltered by long exposure to the air. Nitric acid, in small quantity, heightened the tint, but a larger dose changed it to a dirty orange colour, while potash turned it to a dingy vinous grey. Both the acid and the alkali precipitated many white flakes from the fluid. The purple tint is readily transferred to spirit when the animal is immersed in it; the tincture retains this colour for awhile, but at length becomes of a deep clear red, like that of port wine.

APLYSIA.


PLANORBIS CORNEUS.

A very common shell in ponds and ditches, (*Planorbis corneus*,) coiled up like a ram's horn, is said to have the same property; a purple fluid is poured out from beneath the mantle, but it is so fugitive that no application can prevent its speedily turning to a dull rusty colour.

Colonel Montagu mentions one of our marine shell-fish (*Scalaria clathrus*) as secreting a purple juice. "It may be collected either from the recent or dried animal, by opening the part behind the head; and as much can be procured from five individuals as is sufficient, when mixed with a few drops of spring-water, to cover half a sheet of paper. Neither volatile nor fixed alkali materially affects it; mineral acids turn it to a bluish green, or sea-green; sulphuric acid renders it a shade more inclining to blue; vegetable acids probably do not affect it, since cream of tartar did not in the least alter it. These colours, laid on paper, were very bright, and appeared for some months unchanged by the action of the air or the sun; but, being exposed for a whole summer to the solar rays, in a south window, they almost vanished. The application of alkali to the acidulated colour always restored it to its primitive shade, and it was as readily changed again by mineral acid." *

SCALARIA.

I have already mentioned some thread-spinners among the Mollusca; there are others which have the power of forming threads of silky substance much stronger and more durable than those of our pond snails. The Common Mussel (*Mytilus edulis*) is one of these marine silk-worms; and we have a good many others. The bundle of threads, familiar to many of my readers as the *beard* of the shell-fish, is the substance in question, termed by naturalists *byssus*, a Greek word originally signifying silk; and the use to which it is applied by the animal itself is that of a cable to moor itself to the solid and immovable rock, that it may not be washed away by the violence of the waves. The mode in which the threads are formed, and the organ by which they are secreted, are thus described by Professor Rymer Jones:—

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* Test. Brit. Supp. p. 122.

"The foot in the Mussel is of small dimensions, being useless as an instrument of progression. By its inferior aspect it gives attachment to the horny threads of the byssus, which are individually about half an inch in length, or as long as the foot itself, by which, in fact, they are formed, in a manner quite peculiar to certain families of Conchifera; no other animals presenting a secreting apparatus at all analogous, either in structure or office, to that with which these creatures are provided. The manner in which the manufacture of the byssus is accomplished is as follows: A deep groove runs along the under surface of the foot, at the bottom of which thin horny filaments are formed by an exudation of a peculiar substance, that soon hardens and assumes the requisite tenacity and firmness. While still soft, the Mussel, by means of its foot, applies the extremity of the filament, which is dilated into a kind of little sucker, to the foreign substance whereunto it wishes to adhere, and fastens it securely. Having accomplished this the foot is retracted; and the thread, of course, being drawn out of the furrow where it was secreted, is added to the bundle of byssus previously existing, all of which owed its origin to a similar process."*

Whoever has attempted to wrench up a Mussel from one of those shallow rock-pools, in which they lie as closely packed as paving stones, will have had proof of the great strength of these threads, no small violence being required to detach one. But there is an example on record, where the strength of the threads has been turned to such account as to give this Mollusk a second claim to be included in the list of such species as are beneficial to man.—"At the town of Bideford, in Devonshire, there is a long bridge of twenty-four arches across the Torridge river, near its junction with the Taw. At this bridge the tide flows so rapidly that it cannot be kept in repair by mortar. The Corporation, therefore, keep boats in employ to bring mussels to it, and the interstices of the bridge are filled by hand with these mussels. It is supported from being driven away by the tide entirely by the strong threads these mussels fix to the stonework; and by an act, or grant, it is a crime liable to transportation for any person to remove these mussels, unless in the presence and by the consent of the corporative trustees."

There are bivalve shells allied to the mussel, called *Pinna*, usually of very large size, but of thin and delicate structure. The threads spun by these are long, fine, glossy, and produced in great abundance; they are capable of being twisted like silk, and the inhabitants of Sicily weave them into a sort of cloth remarkable for its softness and warmth, but which refuses to take any dye. In the British Museum, together with some very fine specimens of the shells of this Mollusk, there is a pair of gloves made of its byssus; but articles made of this material are very costly, and cannot be considered in any other light than that of curiosities. Pope Benedict XV, in 1754, had a pair of stockings presented to him which were woven from the silk of the *Pinna.* These were the subject of general admiration, from the extreme delicacy of their texture—well shown by the minuteness of the box in which they were enclosed.

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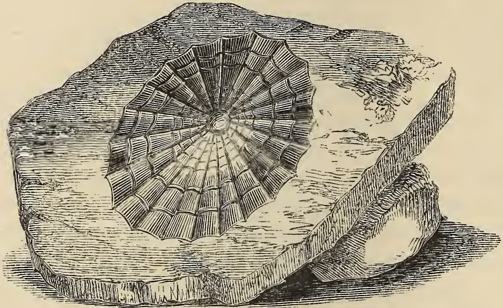
* Animal Kingdom, p. 383.

The mention of the ship-worm naturally presents to the mind another tribe of boring Mollusca,—those which perforate hardened clay, and even stone. These, belonging to various genera, are sufficiently common on our own coasts. Different species of *Pholas* excavate their burrows, which resemble the holes bored by augers or large gimlets in wood, clay, and sandstone; the *Venerupis* in shale and similar friable rocks, the *Lithodomi* and *Saxicavæ* in the limestone, and the *Gastrochæna* in limestone, fluor, and granite. A curious example of the boring powers of one of these species, the *Modiola lithophaga*, occurs at Pozzuolo, in the Bay of Naples, where a colony of these Mollusks had settled themselves in the pillars of the temple of Jupiter Serapis during the period of its submersion. At the height of ten feet above the base of the three standing pillars which remain, and in a position exactly corresponding in all, is a zone of six feet in height, where the marble has been scooped into cells by these Mollusca. The holes are to the depth of four inches; and it is observed that the nodules of quartz and feldspar, which sometimes occur in the hard limestone of the pillars, are untouched.

Many theories have been invented to account for the singular power exercised by these animals, such as the following; that the animals entered the rock while it was in a soft and plastic state, and that it afterwards hardened around them—that the animal poured out some peculiar fluid which had the chemical property of dissolving the rock—that the latter was ground away by the roughnesses on the shells as they revolved, as if by the action of a rasp or file—that the minute particles of the stone were one by one separated and driven off by the force of currents of water, produced by vibrating cilia: but all these theories appear to be set aside by the discovery of Mr. Albany Hancock, one of the highest living authorities on the subject. This gentleman finds that the excavating instrument is the anterior portion of the animal, either the foot and the edges of the mantle, or the edges of the mantle solely. These organs are fitted for the office they are to perform, not only by their position and figure, and their pliability and muscular structure,—made more than commonly muscular for the duty,—but also by being armed with a rough layer of numerous crystalline particles of various sizes and shapes, chiefly five- and six-sided, and all having one or more elevated points near the centre. These crystals are imbedded in the surface of the boring foot and thickened edges of the mantle; and, consisting, probably, of silex or flint, either pure or in combination with some animal matter, they form a sort of file,—superior, however, to any of our workmen's files in this, that the surface keeps itself always in a proper state of roughness for trituration. This is done by an organic law, which causes the crystals to be constantly shed, and as constantly renewed.*

All the borers above alluded to are Bivalves, and I know of no other Mollusk which can properly be classed with them. A common Gasteropod, however, the familiar Limpet (*Patella vulgata*), excavates the rock on which it lives to the extent of making a depression, more or less deep, exactly corresponding to the shape and size of the margin of its shell. When one removes a Limpet from its firm adhesion and finds a hollow beneath it, evidently made to contain its body, one is ready to conclude that the animal is a permanent tenant of the spot, never moving from it; and when we learn that the food of the Limpet consists of sea-weeds, we wonder how it is possible that a stationary animal can find vegetable food. But the truth is,



LIMPET.

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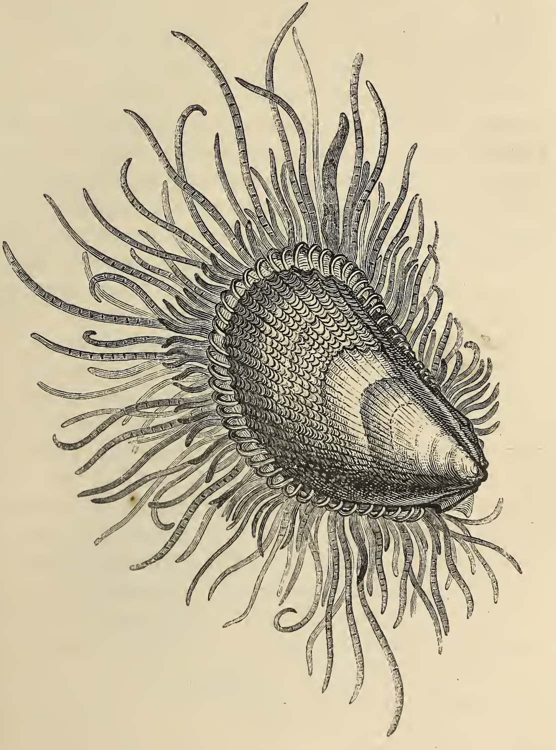
* Ann. and Mag. N. H. Oct. 1848.

I believe, that the Limpet wanders away from its hollow during the night, returning to it as a home by an infallible instinct on the approach of morning. The mode in which the excavation is performed is the same as that just mentioned in the case of the borers, the whole under surface of the foot being furnished with sharp crystals of flint imbedded in its substance.

In general the stony shells of the Mollusca afford them a sufficient protection, but a few species construct for themselves nests. A native example of this instinct is described in interesting terms by the Rev. D. Landsborough, who obtained it in Lamlash Bay:—

"The most interesting, though not the rarest, thing we got was *Lima hians*. I had before this some specimens of this pretty bivalve, and I had admired the beauty and elegance of the shell; but hitherto I had been unacquainted with the life and manners of its inhabitant. Mr. and Miss Alder had got it in the same kind of coral at Rothesay, so that when Miss Alder got a cluster of the coral cohering in a mass, she said, 'O, here is the *Lima's* nest!' and breaking it up, the *Lima* was found snug in the middle of it. The coral nest is curiously constructed, and remarkably well fitted to be a safe residence for this beautiful animal. The fragile shell does not nearly cover the Mollusk, the most delicate part of it, a beautiful orange fringe-work, being altogether outside of the shell. Had it no extra protection, the half-exposed animal would be a tempting mouthful—quite a *bonne-bouche* to some prowling haddock or whiting; but He who tempers the wind to the shorn lamb, teaches this little creature, which He has so elegantly formed, curious arts of self-preservation. It is not contented with hiding itself among the loose coral, for the first rude wave might lay it naked and bare. It becomes a marine-mason, and builds a house or nest. It chooses to dwell in a coral grotto; but in constructing this grotto it shows that it is not only a mason, but a rope-spinner, and a tapestry-weaver, and a plasterer. Were it merely a mason, it would be no easy matter to cause the polymorphous coral to cohere. Cordage, then, is necessary to bind together the angular fragments of the coral, and this cordage it spins; but it spins it as one of the secrets of the deep. Somehow or other, though it has no hand, it contrives to intertwine this yarn which it has formed, among the numerous bits of coral, so as firmly to bind a handful of it together. Externally, this habitation is rough, and therefore better fitted to elude or to ward off enemies. But though rough externally, within all is smooth and lubricous, for the fine yarn is woven into a lining of tapestry, and the interstices are filled up with a fine slime, so that it is smooth as plaster-work. . . . .

"When the *Lima* is taken out of its nest, and put into a jar of sea-water, it is one of the most beautiful marine animals you can look upon. The shell is beautiful; the body of the animal within the shell is beautiful; and the orange fringe-work, outside of the shell, is highly ornamental. Instead of being sluggish, it swims about with great vigour. Its mode of swimming is the same as that of the scallop. It opens its valves, and, suddenly shutting them, expels the water, so that it is impelled onwards or upwards; and when the impulse thus given is spent, it repeats the operation, and thus moves on by a succession of jumps. When moving through the water in this way, the reddish fringework is like the tail of a fiery comet. The filaments of the fringe are probably useful in catching its prey. They are very easily broken off, and it is remark-



LIMA.

able that they seem to live for many hours after they are detached from the body, twisting themselves like so many worms."*

Thus we have slightly touched a few of the details of the history of this great division of animated beings; and we discover that they are not less rich in interesting endowments and faculties, in various contrivances and compensations, in singular habits and instincts, than other animals higher in the scale of organization. But it is only when we study the Mollusca as living beings, that we discover these points of varied interest. The mere collection of shells, however curious their forms and brilliant their colours, would impart but a small amount of knowledge when separated from the animals to which they belong. "The shell-collector of former days looked upon his drawers, if they were rich in rare species or varieties, as containing an assemblage of gems; and, indeed, the enormous prices given for fine and scarce shells, joined with the surpassing beauty of the objects themselves, almost justified the view which the possessor took of his cabinet of treasures. They were to him really 'les delices des yeux et de l'esprit;' and the energetic zeal with which he collected, and the sacrifices that he made to procure a fine and perfect Many-ribbed harp, a Gloria maris, or Cedo nulli, among the cones; an Aurora or Orange-cowry, a Voluta aulica, or Voluta Junonia, &c., were only comparable to the extravagances of those visited by the tulip mania when it was at its height. But though they were the delight of his eyes, they were, in nine cases out of ten, little more to the owner of them: they were mere trinkets on which he looked dotingly, without knowing, and scarcely wishing to know, the organization of the animal whose skeleton only was before him."*

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* Excursions to Arran, p. 319.

In these days, however, the examination of the shell is considered by all who possess any claim to science, as subordinate to the history of the entire animal.

Naturalists arrange the MOLLUSCA in six classes, named *Cephalopoda*, *Pteropoda*, *Gasteropoda*, *Conchifera*, *Brachiopoda*, and *Tunicata*. Of these the first three are sometimes distinguished as *Encephala*, or furnished with a head; the last three as *Acephala*, being destitute of that organ.

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[*] Penny Cyclop., art. MALACOLOGY.

CLASS I. CEPHALOPODA.

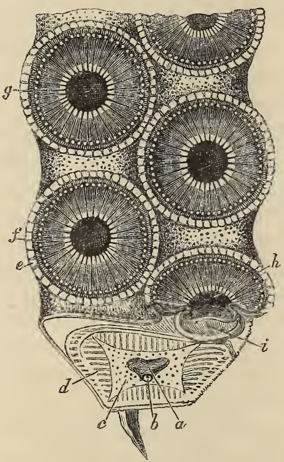
(*Head-footed Mollusks.*)

If we were to take a Poulpe or a Cuttle-fish from some hole or tide-pool in the rocks, and look upon its many flexible arms studded with sucking disks, its sack-like body, its green staring eyes, and its bird-like beak, we should be ready to say that such an animal presents but a slight analogy with the sluggish and almost shapeless creatures familiar to us under the name of shell-fish. And, in truth, the former do possess a higher rank in the scale of animal life, having their senses developed into greater perfection, and forming, indeed, the link by which the latter take hold of the races which, from their elaborate organization, are placed at the summit of the scale—the Vertebrata.

We shall better understand the connexion between the present Class and other Mollusca, by considering, with Cuvier, that "the mantle unites beneath the body, and thus forms a muscular sac which envelopes all the viscera. This body, or trunk, is fleshy and soft, varying in form, being either spherical, elliptical, or cylindrical, and the sides of the mantle are in many of the species extended into fleshy fins. The head protrudes from the muscular sac, and is distinct from the body: it is gifted with all the usual senses, and the eyes, in particular, which are either pedunculated or sessile, are large and well developed. The mouth is anterior and terminal, armed with a pair of horny or calcareous mandibles, which bear a strong resemblance to the bill of a parrot, acting vertically one upon the other. Its situation is the bottom of a subconical cavity, formed by the base of the numerous fleshy tentacular appendages which surround it, and which have been termed arms by some naturalists, and feet by others."

These fleshy flexible feet are characteristic of the Class, and give to it its systematic appellation of *Cephalopoda*, signifying head-footed. They are instruments of locomotion; the animal being enabled to crawl awkwardly upon this circle of feet, head downwards. But their chief use to the animal is as organs for the seizing and holding of prey; and for this purpose they are eminently qualified. Each arm is furnished with a double row of sucking disks, each of which on being applied to any surface adheres to it at the will of the animal with immense force, so that it is easier to tear away the substance of the limb while the creature maintains its hold, than to release it from its attachment; and even after death, the suckers continue to retain a considerable power of adhesion.

The manner in which these suckers act, will be understood by a reference to the principle of a cupping-glass. Each one consists of a firm fleshy or cartilaginous ring, across which a disk of muscular membrane is stretched, with a circular aperture in the centre. A cone-shaped mass of flesh fills this aperture, like a piston, capable of being drawn backward. The membranous disk itself can also be drawn in. Now, let us suppose that one of the sucking disks of a tentacle touches any object fit for prey, such as a fish, for example, gliding by. The instant that the Cuttle feels the contact, instinctively, and with the speed of lightning, it retracts the fleshy piston; a vacuum is thus created, and the edges of the disk are pressed against the surface of the victim, with a force equal to the weight of the water that is above it, added to the weight of the atmosphere. If need be, as when the victim makes strenuous efforts to escape, the vacuum, and consequently the adhesion, is increased by the withdrawal of the membranous disk.



STRUCTURE OF SUCKER.

This apparatus, powerful as it is, is but one out of a thousand instruments of the same kind with which the animal is furnished. Our common Poulpe (*Octopus vulgaris*) has eight tentacular arms, and every one of these carries one hundred and twenty pairs of sucking disks. The struggles of the unhappy victim once touched by the fatal spell, only ensure its speedy destruction; for as it writhes and darts to and fro, it ever comes into contact with others of the disks in succession, each of which adheres. Others of the arms now entwine themselves about it, and thus it is surely dragged to the central mouth, where the sharp and horny beak soon cuts it to pieces in spite of its scaly armour. The effective power of this apparatus is graphically described by Mr. Broderip:—

"We well remember, in our youth, going far out with an old fisherman of Dawlish, to visit his floating nets which he had laid for the pilchards. As we looked down into the clear blue water, we could see that the number of fish entangled was great; but, to the great discomfiture of the fisherman, who was eloquent on the occasion, almost every other fish was locked in the embraces of a cuttle-fish, plying his parrot-like mandibles to some purpose. The fisherman, who seemed to regard these unbidden guests as an incarnation of all evil, carried a capacious landing-net, but so quick was the sight of these Cephalopods, so ready were they in letting go, and agile in darting back or sideways clear of the net, that, though the greedy creatures held on to the last moment, the fisherman did not secure above three out of the crowds that had spoiled his haul. Upon mentioning this to Mr. Owen, he informed us that the muscular arrangement enabled the animal, when it was disposed to let go its hold, to push forward the piston, and thus in a moment destroy the vacuum which its retraction had produced."*

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* Penny Cyclop. art. CEPHALOPODA.

These highly endowed and repulsive creatures are formidable even to man. We may pass by, until better authenticated, the stories told by old naturalists, of Cuttles inhabiting the Indian Seas, with tentacles as long and thick as a ship's mast, which they are said to throw over vessels and drag them under water. But Mr. Beale, who has so largely increased our knowledge of the Sperm Whale, recounts a sufficiently fearful rencontre which he had with a species of *Octopus*, while searching for shells upon the rocks at the Bonin Islands. He was much astonished at seeing at his feet a most extraordinary looking animal crawling towards the surf, which it had only just left. It was creeping on its eight legs, which, from their soft and flexible nature, bent considerably under the weight of its body; so that it was lifted by the efforts of its tentacula only a small distance from the rocks. It appeared much alarmed at seeing him, and made every effort to escape. Mr. Beale endeavoured to stop it by pressing on one of its legs with his foot; but although he used considerable force for that purpose, its strength was so great that it several times liberated its member, in spite of all the efforts he could employ on the wet and slippery rocks. He then laid hold of one of the tentacles with his hand, and held it firmly, so that the limb appeared as if it would be torn asunder by the united efforts of himself and the creature. He then gave it a powerful jerk, wishing to disengage it from the rocks, to which it clung so forcibly by its suckers. This effort it effectually resisted; but the moment after, the apparently enraged animal lifted its head with its large projecting eyes, and, loosing its hold of the rocks, suddenly sprang upon

Mr. Beale's arm, which he had previously bared to the shoulder for the purpose of thrusting it into holes in the rocks after shells, and clung with its suckers to it with great power, endeavouring to get its beak, which Mr. Beale could now see, between the roots of its arms, in a position to bite. Mr. Beale declares that a sensation of horror pervaded his whole frame, when he found that this monstrous animal had fixed itself so firmly on his arm. He describes its cold slimy grasp as extremely sickening; and he loudly called to the captain, who was also searching for shells at some distance, to come and release him from his disgusting assailant. The captain quickly came, and taking Mr. Beale down to the boat, during which time the latter was employed in keeping the beak of the cuttle away from his hand, quickly released him by destroying his tormentor with the boat-knife, when he disengaged it by portions at a time. Mr. Beale states that this Cephalopod must have measured across its expanded arms about four feet, whilst its body was not bigger than a large clenched hand.*

In one genus of this Class the action of the suckers is increased by a strong and sharp hook which projects from the centre of each. During action these hooks are plunged into the flesh of the victim, securing a yet firmer hold; added to which the two long arms, which are so endowed, and which are over and above the eight possessed by the Poulpe, are capable of being firmly locked together, and thus can be made "to cooperate in dragging to the mouth such powerful or refractory prey as singly the arms might be unable to subdue."

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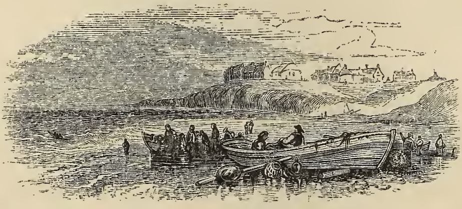
* Hist. of the Sperm Whale.

Most of the species of the Class are destitute of any external covering, but a few are protected by a shell. An immense number of fossil species, however, belonged to the latter division, known by the names of *Belemnites*, *Nummulites*, *Orbulites*, *Ammonites*, &c. The most important existing species possessing a shell, are te Pearly Nautilus of the tropical seas, and the Paper Nautilus of the Mediterranean. The former of these possesses four gills, a peculiarity which distinguishes it from all its fellows: Professor Owen, therefore, proposes to divide the Class into two Orders; the one including the Pearly Nautilus, called *Tetrabranchiata*, or four-gilled; the other including the rest of the existing species, named *Dibranchiata*, or two-gilled.

As the animals belonging to the Molluscous Division are very numerous, I propose to limit this volume to those families which are represented by species existing in and around the British Islands, contenting myself with an occasional slight notice of such foreign kinds as have anything particularly interesting in their history. I shall therefore at once proceed to the second of these Orders.



ORDER DIBRANCHIATA.

(*Two-gilled Cuttles.*)

THE creatures composing this order approach nearest to the Vertebrate animals of all the Mollusca. They have a distinct brain included in a box of cartilage—the vanishing remains of a bony skull; they have large highly-coloured and complex eyes, protected in some species by eyelids; and ears of simple structure, hollowed in the cartilage of the rudimentary skull. They are remarkable for having three separate and well organized hearts, one for the circulation of the arterial blood through the body, the others for the projection of the venous blood through the two gills.

Any person who has had an opportunity of examining one of these animals in a living state, must have been struck with a very curious phenomenon. Over the whole surface of the body there are coloured spots which are perpetually changing their position and figure, running into each other and separating, playing hither and thither, contracting and dilating, appearing and disappearing, with great velocity and in the most singular manner. On close examination, it appears evident that these changes are owing to a fluid which moves irregularly within the substance of the skin. Even after death the spots continue to play for a considerable time, and that on small portions of the skin cut away from the rest.

The cause of this curious appearance is not yet thoroughly understood. Milne-Edwards, whose opinion is entitled to the highest respect, gives the following explanation of it:—"The skin of these animals is furnished with a number of differently-coloured spots, which alternately appear and disappear, and if a portion is put under a microscope, it may be perceived that these changes depend on the contraction of small vesicles filled with a coloured liquid, which reach from the surface of the skin to a considerable depth. When one of these spots appears, the liquid, corresponding here to the pigment in the other case, is propelled towards the superficial part of the vesicle, and there displays itself; whilst during its disappearance it is forced into the deeper parts by the contraction of this superficial point itself, which then becomes almost invisible." *

FAMILY SEPIADÆ.

(*Cuttles and Squids.*)

The lingering rudiment of a vertebrate skeleton in these animals has been already noticed; their body encloses, however, a solid support of quite another nature, which represents the true shell so characteristic of Mollusca generally. Within the substance of the mantle, if we slit it up along the line of the back, we find an oblong cavity, within which lies loose, and unconnected with it a large plate, horny in some species and shelly in others. The pen of the common Squid (*Loligo vulgaris*) is of the former texture; the substance called cuttle-bone, so often found on sandy beaches, is of the latter; but both are strictly analogous to the shell of the slug, which is also enclosed within the mantle; and both are formed in the same manner, namely, by a deposition of horny or shelly matter in a fluid state from the sides of the containing cavity.

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* Edinb. New Phil. Journ. XVII. 319.

The animals of this Family have ten arms, two of which, greatly longer than the rest, are very slender except near their tips, which are dilated; these extremities alone are furnished with suckers. The other eight arms are short, thick, and furnished throughout their whole length with suckers, forming a double row along their under surface.

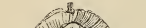
The body is generally lengthened, more or less flattened, with the skin dilated on each side so as to form a pair of wings or fins. It is probably by means of the impetus afforded to the body by these expansions, that some species of the Family are enabled to throw themselves out of the water, and to shoot along through the air to a considerable distance with a motion that resembles flight. These are commonly called Flying Squid.

Mr. F. D. Bennett describes a portion of the Northern Pacific as peculiarly animated by the presence of various oceanic creatures. The Albacore, the Sword-fish, the Barracuda, the Bonita, the Flying-fish, are mentioned, and among them the Squid, whose movements closely resembled those of the last-named volatile fish. "During a calm, in lat. 30° N., the Flying-squid appeared in larger flights than we had ever before witnessed; persecuted probably by the Albacore (which select this tranquil time to descend deep in the water, and to rove far from the ship in quest of food) they rose from the sea in large flocks, leaping over its smooth surface, much in the same manner, and to the same height and distance, as the Flying-fish. Many of them were captured by birds during their leaps, and one individual, in making a desperate effort to escape some aquatic pursuer, sprang to a considerable height above the bulwarks of the ship, and fell with violence upon the deck."*

Genus *Sepia.*

(*The Cuttle.*)

In this genus, which contains our commonest species of the Order, the body is oblong and flattened, with the side-fins extending along its whole length. The mantle is free at its front margin; the suckers are supported by horny hoops with entire edges. The internal support is shelly, and is composed of a succession of extremely delicate plates, sustained by slender columns, regularly arranged, the spaces between the plates being filled with air.



CUTTLE-BONE.

Many of my readers are doubtless familiar with the object here represented, so frequently cast up by the waves upon our smooth sandy beaches: it is the shell of the common Cuttle-fish (*Sepia officinalis*). Its use is not only to give firmness to the soft and jelly-like body of the animal, but to aid it in swimming by its buoyancy; for though the material of which it is composed is stone, from the delicacy of its texture and the peculiar arrangement of the plates, the large proportion of air enclosed within it renders the whole lighter than water.

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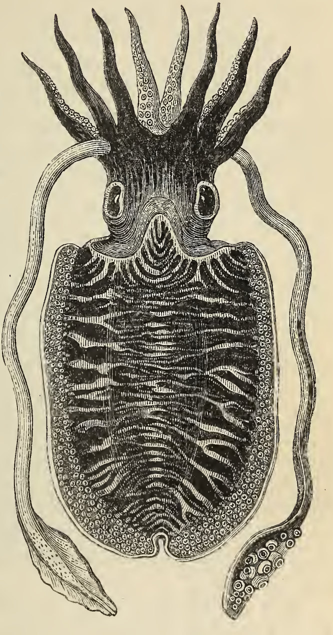
* Whaling Voyage round the Globe.

The Cuttle is about a foot in length, of an oblong form. Its colour is a dull, dirty white, mottled and spotted with those changing veins of fluid, already described, of a reddish brown hue. The texture of the body is soft and flabby, but, notwithstanding its unpleasing appearance, it forms a wholesome and agreeable dish wherever prejudice does not preclude its use. When well cooked the flesh is tender and digestible, bearing considerable resemblance to tripe.

I have already alluded to the inky fluid secreted in an internal reservoir within the body of the Cuttle. It is poured forth in copious quantity from a funnel-like tube beneath the mantle, and is intended as a means of concealment, and of annoyance to its pursuers. "A gallant officer who was inconsiderately collecting shells in a pair of immaculate white trowsers, came suddenly upon



CUTTLE.

one of the naked Cephalopods snugly harboured in a recess in the rock. They looked at each other, and the Cuttle, who had his eyes about him, and knew well how to use them, upon seeing the enemy advance, took good aim, and shot so true that he covered the snowy inexpressibles with the contents of his ink-bag, and rendered them unpresentable either in drawing-room or dining-room."*

Entangled among the sea-weeds washed up on the sea-beach in the latter part of summer, we occasionally see what at first sight we are ready to take for a bunch of purple grapes. The fisherman indeed calls them *sea-grapes*, so close is the likeness in colour, size, and aggregation. But if we take the cluster into our hand and examine it, we shall see that their texture is leathery, or somewhat like India-rubber, that the extremity of each berry runs out to a point, and that its base springs from a fleshy cord which clings and entwines irregularly around the marine plants. These berries are the eggs of the Cuttle-fish, and if we were to open the tough skin of one, we should find either the white yolk and clear glaire, or else the infant animal, perhaps fully formed and ready to take advantage of this premature opening of his prison, by darting out, with all his organs perfected and all his wits about him.

The parrot-like beak presents a strong exception to the general softness of this animal; it is so hard, stout, and stony, and moved by such powerful muscles, that the strong shells of bivalves and univalves are not able to resist its force: even the hard and stony limpet is dragged from its attachment, and crushed to pieces in these powerful mandibles.

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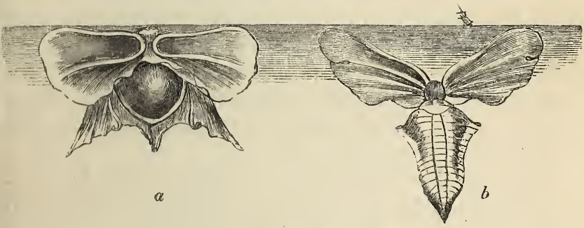
* Penny Cyclop. art. SEPIADÆ.

CLASS II. PTEROPODA.

(*Fin-footed Mollusks.*)

THIS is a very small Class, comprising a few species of curious structure. They are all of diminutive size, and all swim in the open ocean, rarely approaching the shore, except when washed thither by accident. They are all characterised by having a membranous expansion, resembling a large fin, on each side of the head. By means of these organs, the little Pteropod rows itself about in the open sea perpetually; being unfurnished with any means of crawling, or of affixing itself to any solid body. Some of these animals, as the genera *Hyalœa* (*a*) and *Cleodora* (*b*), for example, have the body enclosed in a shell of elegant form, and of a texture resembling the thinnest glass, for delicacy and transparency. The *Cleodora pyramidata*, one of the species of the latter genus, is of extreme delicacy and beauty. The shell is glassy and colourless;



GLASS SHELLS.

very fragile; nearly in the form of a triangular pyramid; with an aperture at its base, from which proceeds a long and slender glassy spine; and a similar spine projects from each side of the middle of the shell. The hinder part of the animal is globular and pellucid, and in the dark vividly luminous, presenting a singularly striking appearance, as it shines through its perfectly transparent lantern. Both of these are found floating in great numbers on the surface of the tropical sea.

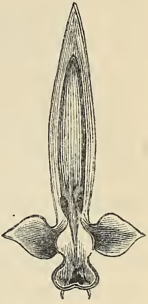
Others are entirely destitute of a shelly covering, as is that little species which occurs in enormous profusion in the Arctic Seas, and which we now proceed to describe.

GENUS *CLIO.*

(“ *Whale-food.*”)

These little creatures have an oblong membranous body, without a mantle; a head formed of two rounded lobes, each of which is furnished with three long tentacles, capable of being withdrawn into a fold of skin, or protruded at pleasure. The mouth, which is terminal, has two small fleshy lips; and two eyes, of elaborate structure, are placed at the back of the neck.

The species best known is that which is commonly called by our northern voyagers, *Whale-food* (*Clio borealis*). Though not more than an inch in length, it occurs in such countless millions as to form the principal part of the nourishment required by the most gigantic of living creatures. The *Clio* bears some slight resemblance to a butterfly just emerged from the chrysalis, before the wings are expanded. Near the head there is on each side a large fin or wing, by the motions of which it changes its place. These motions are amusing; and as the little creatures are so abundant, they make the dreary sea quite alive with their gambols as they dance merrily along. In swimming, the Clio brings the tips of its fins almost into contact, first on one side, then on the other. In calm weather they rise to the surface in myriads, for the purpose of breathing; but scarcely have they reached it before they again descend into the deep. Mr. Scoresby kept several of them alive in a glass of sea-water for about a month, when they gradually wasted away and died. The head of one of these little creatures exhibits a most astonishing display of the wisdom of God in creation. Around the mouth are placed six tentacles, each of which is covered with about three thousand red specks, which are seen by the microscope to be transparent cylinders, each containing about twenty little suckers, capable of being thrust out, and adapted for seizing and holding their minute prey.



CLIO.

Thus, therefore, there will be three hundred and sixty thousand of these microscopic suckers upon the head of one Clio: an apparatus for prehension perhaps unequalled in the creation.

CLASS III. GASTEROPODA.

(*Crawling Mollusks.*)

If we examine the manner in which the common Garden Snail crawls, and especially if we look at it through a pane of glass as it glides up on the outside of the window, we shall see that the whole of the under-part of the body forms a wide fleshy disk, which is applied to the surface upon which the animal moves. Carefully watching this, we perceive that there are minute muscular movements constantly taking place over the whole disk, by means of which the animal advances with an uniform gliding progression. This disk, and its peculiar action, afford the most important character by which this Class of animals is distinguished, and hence they have been named *Gasteropoda*, which signifies belly-footed.

The upper surface of the body is covered with a fleshy cloak, the edges of which usually project in a greater or less degree, overlapping the foot-disk and other organs. This is called the *mantle.*

There is a distinct head, more or less conspicuous, according as it more or less projects from beneath the edge of the mantle; it is furnished with tentacles, varying in number from two to six, arranged in pairs on each side. These are probably delicate organs of touch, and perhaps they may be connected with other senses also. The majority of species are furnished with eyes, commonly placed either at the bases or at the tips of one of the pairs of tentacles. Every one is familiar with their appearance in the snails and slugs of our gardens, in which they are placed as minute shining black points at the tips of the upper tentacles. Many of the marine Gasteropoda, as the great Conchs (*Strombus*) of the tropical seas, have eyes well developed and of elaborate structure. Mr. Swainson says—" In the typical *Strombi*, these organs are so much developed that the iris is richly coloured, and the eyes of some of the larger species have been described to us as particularly beautiful."* According to the Rev. Lansdown Guilding, a naturalist who has enjoyed the advantage of familiarity with these fine Mollusca in their native seas, they have a distinct pupil and a double iris, equalling in beauty and correctness of outline those of birds and reptiles ; and he discovers in the organ a vitreous and an aqueous humour, and the black pigment.† And Mr. J. E. Gray affirms, that " the eyes of the marine carnivorous Mollusca, *Buccinum undatum*, or *Fusus despectus*, and more especially some of the larger *Strombi*, are as fully developed as in the cuttle-fish, showing the cornea and the nearly orbicular crystalline lens almost perfectly formed, as may be seen by any person simply cutting the cornea across, and slightly pressing it, when the crystalline lens will protrude."‡

Some species of this Class, few as compared with the great body, are naked, but the majority are protected by a shell, in some cases very thin, brittle, and glassy, in others somewhat horny, but more generally of a stony texture, and of great solidity and hardness. The chemical composition of these shells, however, varies very little; they consist of carbonate of lime deposited in cells of animal albumen. In the porcelain shells, of which the Cowries (*Cypræa*) afford familiar and beautiful examples, the lime is compact, with so small a portion of animal matter, that when immersed in acid the shell is completely dissolved, no sensible trace remaining. In the pearly shells, such as the genus *Trochus*, the calcareous matter is deposited in layers; and these, when submitted to acids, leave behind an insoluble membrane of albumen which retains the form of the shell.*

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* Malacology, 136.

† Zool. Journ. iv. 172.

‡ Edin. Journ. iii. 52.

The shell is secreted by the mantle. In one family, that of the Chitons, it consists of several pieces, but in general it is simple, and takes the form of a hollow cone produced in various degrees. In the Limpets, which we see adhering so abundantly to our sea-side rocks, the cone is low and nearly symmetrical; but in the great majority of this class, the cone is greatly lengthened and twisted upon itself, so as to form a spire.

The mode in which the shell is formed has been well investigated by Mr. J. E. Gray, whose observations on the subject I shall here take occasion to cite:—

" The shell, which is peculiar to this division of the animal kingdom, may be seen covering the young animal in the egg before it has gained all its organs, as was observed by Swammerdam, and verified by the more extended observations of Pfeiffer, Turpin, and others. They are easily seen in the egg of the *Limnæi*, *Physæ*, *Ancyli*, and *Bithiniæ*, which have a transparent coat.

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* Thomson's Chemistry, v. 54.

" The shells of the newly-hatched animals have been frequently considered as distinct species, and some very thin shells of land Mollusca, such as *Vitrinæ,* have been taken for the young of other well-known species, as *Helix hortensis.* These young shells are easily known by their always being of a pale horn colour; the whorls are generally rather irregular, and enlarge very rapidly; and the apex of the whorl, which was first formed, is generally large and blunt compared with the size of the shell. They are always destitute of colour, for the animal does not deposit the colouring matter until after it has been hatched; and it is therefore generally easy to distinguish, in the young shell, (and sometimes also in the adult,) that part of the top of the spire which formed the shell of the animal when in the egg.

" The shell is formed by the hardening of the animal matter, which is secreted by certain glands on the surface of the body, by means of chalky matter, which is also secreted by similar glands. It has been stated that the unhatched animal, very shortly after it is formed, begins to make its shell; and when it is hatched, deposits on the edge of the mouth of the little shell, which covered its body in the egg, a small quantity of the mucous secretion. This dries, and is then lined with some mucous matter, intermixed with calcareous particles; and when this hardens, it again places on its edge another very thin layer of the mucous secretion, and again lines it as before. The mucous secretion first deposited forms the outer coat of the shell, and is of use in protecting it from injury, while the mucous matter mixed with lime, which is placed within it, forms the substance of the shell itself.

This deposition of mucous, and of mucous mixed with calcareous matter, goes on as the animal grows and feels the want of a larger shell for its protection. The shell is, in fact, moulded on the body of the animal itself, as the body grows; and, for this reason, any irregularity in the body is moulded in the shell.

"The animal has the faculty, also, of mending any break or injury that its shell may have received, if it is not of such a magnitude as to derange all the functions of the animal itself; and it mends them in the same manner as it forms its shell,—that is to say, by depositing first a coat of animal matter, and then lining it with mucous matter, mixed with chalk, to harden it. But as the animal is usually very desirous of getting the repairs done as quickly as possible, and is most probably damaged by the injury it has received, these repairs are generally much more roughly executed than the shell itself, and commonly destitute of regular colour.

"The particles, which vary the colour of the surface of the shell, are deposited while the shell is being increased in size, immediately under the outer mucous coat; and as these particles are also secreted by peculiar glands, the colour is always situated in a particular manner on each species, the glands being gradually enlarged, and gradually separated, but not changed in position by the growth of the shell. All the variations exhibited in the colouring of the different species, or in the different individuals of the same species, are produced by the permanent or temporary interruption of the action of these glands."*

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* Land and Fresh-water Shells, 73.

The part upon which the spire turns is called the pillar. It is sometimes solid, but sometimes it is hollow; in the latter case the perforation is named the *umbilicus*. When the spire is long, the shell is said to be *turbinated*, which is the common form; but in some genera, as *Planorbis*, the convolution takes place in the same plane, and the shell is flat, or even concave. Such shells are termed *discoid*. When the upper part of each turn or *whorl* envelopes or covers that which preceded it, the spire is said to be *concealed*.

In almost all species the convolution is towards the right side. There are a few, however, which turn to the left; these shells are termed reversed. The end of the latest whorl, where the animal protrudes, is termed the mouth or aperture. In order to close this, when the animal withdraws itself into its shell, the hinder part of the foot is usually furnished with a horny or shelly plate, called the *operculum*, which, when the animal contracts, is brought into such a situation, as more or less completely to close the mouth of the shell, when the animal is drawn into its cavity. It has hitherto been observed only in those Mollusca which have pectinate branchiæ, and in two genera, *Cyclostoma* and *Helicina*, among the air-breathing land-shells. The form of the operculum is in general either that of a very low cone, made by successive layers, each one a little larger than its predecessor, or that of a flattened spire, and the texture is either horny or shelly.

The species of *Gasteropoda* are very numerous, and are arranged in five orders, viz.—*Pulmonifera*, *Nudibranchiata*, *Tectibranchiata*, *Cyclobranchiata*, and *Pectinibranchiata*.

ORDER PULMONIFERA.

(*Lung-breathing Mollusks.*)

This extensive Order contains Mollusca which differ from all the rest of the Class, by breathing atmospheric air. There is an orifice situated on the right side, beneath the margin of the mantle, which opens into a chamber lined with a delicate net-work of vessels. This lined cavity is analogous to the lungs of vertebrate animals, and its muscular floor is said to perform alternate motions, answering to those of the diaphragm, by which the lungs are filled and emptied by turns.

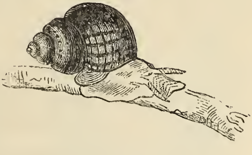
Many of the species inhabit fresh waters; but the greater number are denizens of the land, requiring, however, a damp atmosphere, to preserve them in health and vigour. The close, humid forests of tropical countries sustain the terrestrial species in immense number and variety: the shells of many of these—distinguished by their curious forms, by their large size, by their rich and brilliant colours, often arranged in finely-contrasted bands, and by their delicately sculptured surfaces,—are among the most precious ornaments of conchological cabinets. The aquatic species form, notwithstanding the element in which they live, no exception to the leading character of the Order; they also breathe air, which they obtain by coming periodically to the surface.

In general, the subjects of this Order are protected by an ample spiral shell; but in some this appendage is very minute, concealed within the substance of the mantle, or altogether wanting. Our own country furnishes examples of each of these kinds. All the native species are comprised in five families,—*Cyclostomadæ*, *Auriculadæ*, *Limneadæ*, *Helicidæ*, and *Limacidæ*.

FAMILY CYCLOSTOMADÆ.

This is an extensive family, though represented in Britain by but a single species. The great majority of its members are elegantly formed and beautifully sculptured shells from warm countries. The shell is spiral, ample in its dimensions, with a circular aperture, generally surrounded in the adult with a frill-like, shelly expansion ; it is closed by a spiral, shelly operculum.

The animal has a broad foot, divided longitudinally; a central spiral body, enveloped in a single-edged mantle. There are two tentacles, which are lengthened and contractile, with an eye placed on the outer side of the base of each. The sexes are distinct. All the species are terrestrial, and are generally found on trees, on the leaves of which they feed. The only British species (*Cyclostoma elegans*) is a little shell, about half an inch in length, and rather less in width, of a grey or purplish yellow hue, often marked with two rows of dark spots. The spire is composed of five rounded whorls, marked with numerous close-set, raised lines, running spirally, with finer longitudinal ones between



THE ELEGANT CYCLOSTOMA.

them. There is an umbilicus behind the pillar; the operculum is hard, horny externally, and marked with a single, depressed, spiral line.

This Mollusk lives on vegetable matter, like the snails, and is found in damp places, on a chalky soil. It is not very generally distributed, but is said to be abundant on the warm chalk hills, covered with brushwood, at Caversham, near Reading, in Berkshire. It is common also in the Isle of Portland, where I have seen it numerous in April, crawling on the twigs of shrubs, with the operculum carried behind, in a curious manner.

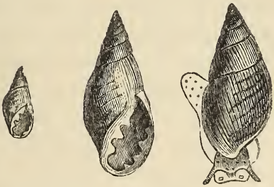
Family Auriculadæ.

The characters of this family are the following:—The animal has a lengthened foot, a lengthened ringed muzzle, two somewhat cylindrical tentacles, with eyes near their bases on the inner side. The body is spiral, placed on the centre of the foot, and invested with a thin mantle, with a thickened edge. There is an ample spiral shell, the pillar of which is plaited at all periods of its life.

Mr. Gray observes of these Mollusca, which are feebly represented in Britain by some three or four small species comprised in three genera, that they appear, by their habit and character, to be exactly intermediate between the land and the fresh-water Univalve Mollusca. They have the sessile eyes of the Pond-snails, placed behind instead of in front of the tentacles, and the subcylindrical tentacles of the Land-snails; but the tentacles are not retractile under the skin of the neck. In the same manner, the *Carychia* and the *Acmea* are terrestrial, living in damp moss; the *Conovuli* live in the mud at the mouths of rivers, or in the sea: they seldom leave salt, or at least brackish water. There are some foreign species which live in ponds, and have all the habits of our Pond-snails, only that their pillar is more distinctly plaited.

The family may be represented by *Conovulus denticulatus*, an oblong, spiral shell, rarely exceeding half an inch in length, of a brown or purplish hue. Its last whorl is long and compressed; the pillar is grooved, with several spiral plates; the throat is also grooved. A remarkable character of this shell is, that the pillar extends no further than the upper part of the last whorl, the upper whorls being destitute of any pillar or internal spiral division. This character is common to most species of the family, and forms, as Mr. Gray observes, one of its best technical distinctions. It is attributed to the animal's absorbing the partitions which separate the upper whorls, and thus converting the spire into a single cavity.

This little Mollusk is by no means common; it has been found in the marshes near Faversham, at the roots of rushes. It is said also to inhabit the clefts of rocks, near high water-mark, as well as the mud left bare by the tide, at the mouths of rivers. The animal feeds, according to M. Bouchard Chantreux, on the detritus of marine plants and rotten wood. It lays twelve or thirteen eggs in the months of June and September, united by a viscid matter into a small mass, which is fixed under the more



THE DENTICULATED CONOVULUS.
(*Nat. size and magnified.*)

humid stones. The eggs are globular, yellowish, and quite diaphanous: they are hatched about the fifteenth day, and the animals reach their full size about the end of the second year. They do not hybernate.

FAMILY LIMNEADÆ.

(*Pond-Snails.*)

The Fresh-water Snails were scattered by Linnæus and his followers among various marine and terrestrial genera, on account of the diversity which is found in the shape and appearance of their shells. Since more attention has been paid by conchologists to the structure of the animal inhabiting a given shell, the close similarity which subsists between them has prompted their union into one family, and that one of the most natural of all those into which the Mollusca are divided. They are distinguished by the following characters:—

The animals have a lengthened foot, a spiral body, a short, broad muzzle, two large tentacles, triangular and compressed, or awl-shaped, with the eyes near their outer bases. The tongue is furnished with rows of hooked teeth. The mantle, which is ample, has a thin edge, and is protected by a shell of exceedingly variable form, being spiral, turreted, discoid, or simply conical. Those which are spiral are sometimes regular, and sometimes reversed. The colour is generally pale brown, uniform in hue, and the surface is closed with a hard olive skin, technically called the *periostraca*, or that which is around the shell. They are destitute of an operculum.

The habits of these Mollusca are as identical as their structure. They inhabit lakes, ponds, and ditches of fresh water; are found, but less commonly, in rivers, and still more rarely in brackish water. They crawl on the mud at the bottom, or on the stems and leaves of aquatic plants, always coming to the surface, at intervals, to take in a fresh supply of air into the lung chamber for respiration. They may frequently be seen floating, at the surface of still water, by the expanded foot, the shell being downward and submerged.

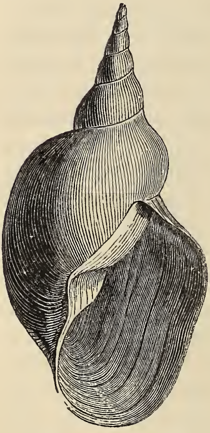
They lay their eggs in round or oval masses ot consistent jelly, each mass containing a number of eggs, varying from three to upwards of a hundred, according to the genus. The masses are attached to plants or stones beneath the surface, and are hatched in about a fortnight after they are deposited.

The Pond-snails are very numerous, and widely distributed, species being found in almost all parts of the world. Twenty-four are reckoned by Messrs. Forbes and Hanley as British.

" It had been supposed that the shells of fluviatile Mollusca could be distinguished from those of the terrestrial kinds, by the edge of the mouth of the shell never being furnished with a thickened internal rib, and not being in the slightest degree reflexed, and that the animal never closes it with an *epiphragm;* however, further examination has shown that when the Pond-snails and the Whirl-shells are left nearly dry by the evaporation of the water, either by the heat, or by dryness of the weather in winter, these animals assume the character of terrestrial Mollusca, thicken and reflect their mouth, and form an *epiphragm* to prevent themselves from being destroyed by the drying up of the fluid necessary for their respiration and life." *

GENUS *LIMNEUS.*

In this genus the shell is ovate, oblong, or turreted, thin and horny, and transparent. The aperture is ovate or expanded, the margin entire, and the pillar marked with a single oblique plait running into the axis. The animal has a short broad foot; the head and snout, and the tentacles, are also all characterised by peculiar breadth; the two eyes are placed in front of the base of the last-named organs. The mantle has an even edge sometimes reflected upon the shell, but never covering it. The tongue is armed with many transverse rows of short, hooked teeth.



LAKE MUD SHELL.

The largest British species is the Lake Mud Shell (*Limneus stagnalis*), which attains a length of two inches, and a diameter of one. In the large rivers of Eastern Europe it grows to a much larger size. The shell is thin and brittle, of a greyish hue, often covered with an extraneous coat; the spire is composed of about seven whorls, tapering to a fine point; the last whorl is striated lengthwise, and generally crossed by transverse raised lines, giving it an angular appearance; this whorl is large, and often greatly swollen. The pillar fold is strongly marked, almost forming an umbilicus. The animal is of a yellowish hue, paler beneath.

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* Gray's Land and Fresh-water Shells, 229.

In stagnant and slow moving waters this species is not uncommon; and, on a warm summer's day, numbers of this and other species may be seen traversing the mud, climbing the aquatic plants, or mounting to the top, and floating on the unruffled surface in a reverse position. The principle by which an animal, heavier than water, is thus enabled to float, is not very easy of explanation; a parallel to it, however, is afforded by the familiar experiment of carefully laying a needle on still water, where it will float as long as it remains unshaken. The swimming body must, of course, be considered as in contact with the incumbent air, the cohesive power of which to the body, and among its own particles, is probably sufficient to overcome the force of gravity. But the Pond-snail not only floats, but swims at the surface, traversing its pool with a smooth, gliding motion, in an undulating line. M. de Quatrefages is of opinion that the progression of Mollusks, in this reversed position on the surface of the water, cannot be made by any muscular action of the foot; and he ascribes the motion to the action of the vibratile cilia, which cover the entire body as well as the sole of the foot. Dr. Johnston,* however, sets in opposition to this opinion the fact, that an *Eolis* crossing a basin can at once stop and remain there for any time, though, during all this period of rest, the cilia are in as active a state as when the creature was in motion. I would add, also, as adverse to the opinion of the French naturalist, that in the *Eolis* and other floating species I have distinctly observed the action of the foot muscles; the animal, indeed, literally crawls on the under surface of the stratum of air, just as if it were a plate of glass.

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* Introd. to Conchol. 130.

The curious habit which these Water-snails have of rising perpendicularly through the water, and the still more curious power of spinning a thread, by the help of which this feat is accomplished, have been already described in the earlier pages of this work. I shall merely add to these particulars of their history, that they lay in summer large oval masses of clear jelly, which they affix to the stalks and leaves of submerged plants. Each mass contains from 100 to 130 eggs, which are hatched in sixteen days.

FAMILY HELICIDÆ.

(*Snails.*)

This is an immense family. Between sixty and seventy species belonging to it are enumerated as natives of the British isles, and those which inhabit foreign countries are far more numerous. The technical characters may be thus described. The head and tentacles are capable of being wholly withdrawn into the body, in which state they are covered by the infolded skin as with a sheath; the end of the tail tapers to a point, and is destitute of a gland. The lung chamber is generally in front of the body, with the breathing hole at its hinder part.

The body is spiral, the mantle thin, with a thickened edge lining the inside of an external shell.

The indigenous members of this extensive family are familiar to every one. Some of them are destructive and voracious tenants of our gardens; others occur to us in our summer walks, swarming by scores on the banks and hedgerows; and not a few attract our admiration by their clean globose shells, and by the beauty of the colours, frequently disposed in spiral bands, with which they are adorned. But the beauty of our native species is far surpassed by many of those from the tropics, many of which, especially those of the genus *Bulimus*, shine in the most gorgeous colours, crimson, scarlet, orange, yellow, green and blue; and many of them are of gigantic size.

All the members of the family are voracious vegetable feeders; many of them devour indiscriminately the leaves of various plants, especially such as are tender either from youth, or from incipient decay. To aid them in crushing down the vegetable fibre, the mouth, which is situated on the under part of the head, is armed with a cutting instrument of beautiful contrivance. The upper one of the two fleshy contractile lips is armed with a broad horny plate, the lower edge of which is free, very sharp, and slightly curved, forming in fact a knife, admirably adapted to divide the leaves and soft parts of vegetables, when they are pressed by the action of the lips against its cutting edge. The floor of the mouth is provided with a small cartilaginous tongue, covered with delicate transverse striæ, and so disposed that by its movements it is well calculated to assist in propelling the food into the œsophagus.

A moist state of the atmosphere combined with a certain degree of warmth, though not essential to life, is necessary to the healthy performance of its functions in the Snails. On the approach of winter in cold or temperate climates, they hide themselves in protected situations, where they construct, in a manner presently to be described, a tight chamber, within which each individual sleeps away the cold season in a torpid state. During the summer, a continuance of dry weather will induce a similar retirement and a similar torpidity, though more brief in its duration.

The great majority of the species deposit a number of eggs glued together into a mass, and concealed under rubbish, the bark of decaying trees, dead leaves, or moss, or beneath the surface of the ground. Those of the Garden Snail (*Helix aspersa*) are soft, semi-transparent, and about as large as small peas; those of many foreign species are oval, and are enclosed in a firm, white, calcareous shell, like those of birds. Some of these are of considerable size. That of the magnificent *Bulimus hæmastoma*, from the West Indies, is as large as a blackbird's egg, and that of *Bulimus ovalis* from Brazil still larger. The latter species has produced eggs in England. A specimen had been presented to the Horticultural Society, and was kept in their conservatory at Chiswick. At first it appeared rather sickly; but after it had been kept in the hot-house for some time, it recovered, and began to move about. Mr. Booth, who was on the spot, says—"It cannot now be correctly ascertained when it produced the first egg, but it was very shortly after its arrival—I should think about the beginning of November. This egg was sent by the desire of Mr. Sabine to the Zoological Society. About the same time this year (1829) it produced a second egg, and three weeks afterwards a third; the latter was unfortunately broken by the animal itself, but the former is still in preservation. It fed upon lettuces, and the tender leaves of cabbages; the former seemed to be its favourite food. Sometimes it would devour two large lettuces, and then remain for days afterwards without touching food, or moving from its place, except when cold water was sprinkled upon it. During the day, it was usually in a dormant state in the shade; but towards the evening, when the house was moist and warm, it would spread itself out, and move from one part to another. It seemed to like moisture, and I have no doubt that it might have been preserved for years, if it had not been accidentally killed. On Saturday last, it was at the end of the house where the fire comes in, and ventured too far upon the hot bricks after they had been watered; in the morning, it was found fixed to them quite dead."*

GENUS *HELIX*.

The animal in this well-known genus has a lengthened, depressed foot, and a large produced central spiral body, covered with an ample shell. The form of the shell is generally more or less globose, but sometimes depressed or flattened; the mouth is large and rounded, but the swelling of the last whorl intruding into it renders the interior of the aperture crescent-shaped; the mouth is strengthened by an internal thickened rib, and its margin, when the animal is full grown, is turned outwards.

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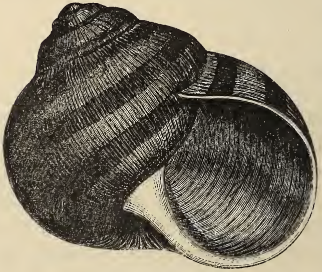
* Zool. Journ. v. 102.

Mr. Gray, in his "Land and Fresh-water Shells of the British Islands," has enumerated twenty-six species of this genus as natives of this country and its adjacent isles. By far the finest of these is the Edible Snail (*Helix pomatia*), which inhabits woods and hedges in chalk districts, in the southern and midland counties of England. The shell of this fine species attains a diameter of two inches, and a height of the same; the last whorl is very large and globose, and all are strongly striated across with close-set lines; the colour is commonly pale brown, with four spiral bands of dark brown; the interior is tinged with violet.

The animal is of a pale greyish-brown, the body studded with warts, the tentacles are long, the foot dilated, marked with impressed lines, forming a network.

Among ourselves these animals are occasionally eaten, and, when properly cooked, are said to be not unpleasant to the taste. Lister tells us how they were dressed in his time. "They are boiled in spring water, and when seasoned with oil, salt, and pepper, make a dainty dish." But on the Continent, as I have before intimated, snails have been from the earliest times an admired luxury. "The



EDIBLE SNAIL.

ancient Romans kept these animals in what were called cochlearia, or snail-stews. These were generally formed under rocks or eminences, the bottoms of which were watered by lakes or rivers; and, if a natural dew or moisture was not found, an artificial one was formed by bringing into the place a pipe, bored full of holes like a watering-pot, through which it was continually sprinkled. The snails required little attendance or food, supplying themselves, in a great measure, as they crawled about the sides or floor of their habitation. To fatten them, however, they were fed with bran and sodden lees of wine.

"These snails are at this day much admired in some parts of the Continent, and are not always used from economical motives; for at Vienna, but a few years ago, seven of them were charged the same price in the inns as a plate of veal or beef. The usual modes of preparing them for the table are by boiling, frying them in butter, or sometimes stuffing them with force-meat; but, in what manner soever they are dressed, their sliminess always remains.

"The greatest numbers, and the finest snails, are brought from Suabia.

"Dr. Townson was shown at Erlau a snailery, which the proprietor informed him was constructed on an improved plan. In our island, he says, this might have had the denomination of a patent snailery, or philosophical snail-sty. It consisted only of a large hole, two or three feet deep, dug in the ground, having a wooden house as a cover. The animals were fed on the refuse of the garden, which was thrown to them."*

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* Bingley's Anim. Biography, iv. 335.

In the latter part of summer, the Edible Snail lays beneath the surface of the earth from sixty to eighty eggs, which are of a globular shape, covered with a white leathery skin, and about as large as dried peas. In from twenty to thirty days, according to the state of the weather, the young snails are hatched, each enclosed in a delicate shell, of a single whorl. A period of thirteen months from the time of hatching suffices, according to M. Bouchard Chantreux, to bring the animal to its full growth.

The name *pomatia*, derived from the word πῶμα, which signifies a lid, refers to the curious covering with which the animal closes the mouth of its shell, to exclude the air during its residence in winter quarters. All the circumstances connected with its hybernation are so interesting that I shall describe them at length from a memoir on the subject by M. Gaspard, condensed in the Zoological Journal, with some valuable notes by Professor Bell.

M. Gaspard remarks that in our temperate climate, as soon as the first autumnal chills are felt, about the commencement of October generally, *Helix pomatia* becomes indolent, loses its appetite, and associates in considerable numbers on hillocks, the banks of ditches, in thickets, hedges, and such places. In a day or two the animals cease feeding, expel the last contents of the intestines, and then hide themselves under moss, grass, dead leaves, or the like rubbish. Here each forms for itself, with the anterior part of its muscular foot, a cavity sufficiently large to contain at least its shell. This cavity it enlarges and excavates by turning itself round on every side, then raising itself against the sides of the cavity, and at last against the roof formed of moss or leaves, or a small quantity of earth, brought there by its motions. When it has succeeded in bringing the aperture of the shell to nearly a horizontal position, it stops. The foot is soon contracted within the shell; the snail then expands, so as completely to cover it, the collar of the mantle, which is at this period very white; and then inspires a quantity of air, after which it closes the respiratory hole. When this is done, a fine transparent membrane is formed with its mucus, and interposed between the mantle and any extraneous substances lying above. The mantle then secretes a quantity of very white fluid over its whole surface, which sets uniformly, like plaster of Paris, instantly forming a continuous covering about half a line thick. When this is hardened, the animal separates its mantle from it by another and stronger mucous secretion; and after a few hours, expelling a portion of the air it had previously inspired, it is enabled to shrink a little farther into the shell. It now forms another lamina of mucus, expires more air, and thus retires farther into the shell. In this way sometimes a fourth, fifth, and even sixth partition are formed, with intermediate cells, filled with air.

Such is M. Gaspard's account; but Mr. Bell remarks that it does not completely explain the manner in which the excavation is formed. "It is not by the pressure of the foot," says the last-named zoologist, "and the turning round of the shell, that this is principally effected. A large quantity of very viscid mucus is secreted on the under surface of the foot, to which a layer of earth or dead leaves adheres; this is turned on one side, and a fresh secretion being thrown out, the layer of earth mixed with mucus is left. The animal then takes another layer of earth on the bottom of the foot, turns it also to the part where he intends to form the wall of his habitation, and leaves it in the same manner, repeating the process until the cavity is sufficiently large, and thus making the sides smooth, even, and compact. In forming the dome or arch of the form, a similar method is used, the foot collecting on its under surface a quantity of earth; and the animal turning it upwards, leaves it by throwing out fresh mucus, and this is repeated until a perfect roof is formed. As I have very often watched this curious process, I am certain of the facts. On removing very carefully a portion of the roof soon after its completion, I was enabled to see the formation of the operculum. In about an hour, or even less, after the hybernaculum is covered in, the whole surface of the collar of the mantle instantaneously pours out the calcareous secretion in considerable quantity. This is at first as fluid as thick cream, but very soon acquires exactly the consistence of bird-lime, being excessively adhesive and tenacious, and in about an hour after it is poured out, it is perfectly solid."

M. Gaspard states that the labour of each individual continues for about two or three days, but that the whole of the month of October is occupied by the general closing of the shells of the species. He adds that, about the beginning of April, the hybernation ceases. "The mode by which their escape from confinement is effected is simple and easily comprehended. The air which is contained in the different cells, and which had been expired on the animal withdrawing itself farther and farther into the shell, after the formation of the operculum, is again inspired, and each separate membranous position broken by the pressure of the hinder parts of the foot, projected through the mantle. When it arrives at the calcareous operculum, the animal, making a last effort, bursts and detaches its most obtuse angle; then, insinuating by littlean d little the edge of the foot between the shell and the operculum, it forces the latter off, or breaks it away."*

FAMILY LIMACIDÆ.

(Slugs.)

In general, the animals of this family resemble those of the preceding. The body, however, is lengthened and slender, attached to the foot by its whole length, instead of rising into a spire. The mantle is generally small, not nearly covering the body. The shell is minute and rudimentary, sometimes concealed within the substance of the mantle, and sometimes altogether wanting.

In general the Slugs are, like the Snails, herbivorous; but the curious genus *Testacella*, of which a species has been found in the neighbourhood of London, feeds almost exclusively on earth-worms.

GENUS *LIMAX*.

Our common Slugs, but too familiarly known, have a lengthened body, with a granular surface, keeled behind. The mantle is small, covering like a shield the fore part of the body. Its substance encloses a small, flat, transparent, oval shell, somewhat resembling the human nail.

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* Zool. Journ. i.

Slugs proper are widely distributed, species being found in various parts of both hemispheres; but the temperate regions of the northern hemisphere are principally troubled with them. The common Grey Slug (*Limax agrestis*) commits great ravages every year in our fields and gardens, notwithstanding the number of birds which make this species their prey; and various means have been devised to get rid of the pest, or at least to diminish its intensity. Quicklime, soot, coal-ashes, and saw-dust, are in turn sprinkled on the ground around tender plants; but the effects of these and similar substances depend upon their dryness, and the inability of the Slug to crawl upon powdery substances. The first shower of rain, however, and even the dews of night, break the spell.

This species varies much in size and colour, being by turns white, pale reddish-grey, and nearly black; but it may be easily distinguished by its body being furrowed with interrupted lines, with a short keel, which is always placed obliquely. The mantle is comparatively large, marked with circular lines; the enclosed shell is very minute, thick, hard, and irregular.

The Grey Slug is very prolific, continuing to lay its groups of eggs from April to the end of November, and depositing from thirty to seventy eggs at each time. The young increase in size rapidly, and reach their full growth in three months from their birth. When irritated, the Slug pours out from the whole surface of its body a copious white mucus, of the consistence of thick white cream, which dries into a white membrane.

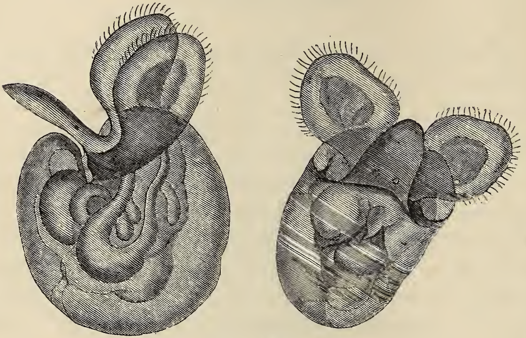
ORDER NUDIBRANCHIATA.

(*Naked-gilled Mollusks.*)

SCARCELY any of the animals which the marine naturalist meets with in his dredging voyages, or his sea-side excursions, are so attractive as those of this Order. They are remarkably elegant in their forms, which present great variety. Their motions are graceful and lively, their colours peculiarly brilliant, and their history and economy marked by points of great interest. Nor is it rarely that the zoologist is gratified with an opportunity of observing these very attractive Mollusks, for the species are numerous, the British shores alone yielding more than a hundred.

These are not air-breathers, like the members of the preceding Order; they are all marine, and respire by means of gills, which are not enclosed within the body, but (at least during action) exposed freely to the surrounding medium. Sometimes these organs are capable of being partially withdrawn into a cavity, situated on the medial line of the back; but more commonly they take the form of simple or branched warts, arranged along the sides. The foot is large and broad. The mantle is ample, and projects above the foot on all sides. None of the species are protected by a shell, except in early infancy. The young, on emerging from the egg, is enclosed in a shell, which closely resembles that of a nautilus, and bears very little resemblance to the parent in its form; it has, therefore, to pass through a metamorphosis before it attains its permanent condition.

The eggs in all the species are numerous. They are deposited, during the spring and summer, commonly in the form of a broad ribbon of clear jelly, attached by one of its edges to some solid substance, and generally coiled, or irregularly twisted, or frilled. The eggs themselves are arranged in close-set rows, crossing the gelatinous belt, and giving an opaque white appearance to the mass, which would otherwise be colourless.



LARVA OF EOLIS.

In general each egg-shell *(chorion)* contains but a single yolk, but in some of the *Dorides* each contains two or three; and in the elegant *Antiopa cristata*, a specimen of which lately spawned in my possession, I found, upon the average, the extraordinary number of sixty yolks in each egg shortly after deposition. The yolk, which is contained within a delicate, transparent, membranous shell or chorion, may be observed changing form. The time required to mature the embryo varies in different species, and probably in the same species under different circumstances; in general from ten to fifteen days is sufficient for this purpose.

The development of the embryo is highly interesting, especially as, owing to the transparency of all the organs, nothing is easier than to watch its progress. I have kept many specimens in glass vases of sea water; and as all the species of this Order are hermaphrodite—that is, the sexual functions are united in the same individual—every specimen obtained is pretty sure to spawn during the season. The yolk, which at first nearly fills the egg-shell, soon becomes a little elongated, with one end diagonally truncated, or, as it were, cut off obliquely; the truncated end then becomes two-lobed, "each lobe exhibiting an imperfect spiral, and having its margin ciliated. The now animated being is seen to rotate within its prison. Shortly the lobes enlarge, and a fleshy process, the rudimentary foot, is observed to develop itself a little behind them, on the medial line; a shell closely investing the inferior portion of the embryo, the lobes and rudimentary foot being uppermost. The shell rapidly increases, and assumes a nautiloid form; afterwards the foot displays, attached to its posterior surface, a circular operculum, which is opposed to the mouth of the shell. The lobes now expand into two large, flattened, ovate appendages, with very long vibratile cilia around the margins, and the larvæ are at length mature. The whole mass of spawn now presents the utmost animation. Hundreds of these busy atoms are seen, each within its transparent, membranous cell, rotating with great agility and ceaseless perseverance, the cilia all the while vigorously vibrating on the margins of the outstretched lobes. The membranous chorion, which by this time has become enlarged, ultimately gives way, no longer able to resist the perpetual struggle within; and the liberated larva, wending its way through the shattered shreds of the general envelope, boldly trusts itself to the open trackless water, where, doubtless, thousands and tens of thousands perish ere they find a fitting resting-place, some being swept away by resistless currents, others falling a prey to ever-watchful and innumerable enemies."*

As the larva increases in age, the foot acquires considerable dimensions. The operculum becomes delicate and transparent, so as to be with difficulty examined; it is, however, seen to be circular, and concentric lines seem to indicate that its growth takes place in the ordinary manner. Besides the long cilia of the lobes, the action of which is under the control of the larva, "the whole surface of the exposed parts is covered with minute cilia, whose vibrations never cease. These cilia serve most probably for respiratory purposes, and may also assist in bringing food to the mouth.

"When the larva is at rest, the oral lobes are pulled back into the shell, and the foot being drawn down, brings along with it the operculum, which closes the orifice. But when in action, the whole of these parts project beyond the opening of the shell, the foot lying back against the spire; and the oral lobes inclining forward, their cilia commence to vibrate, and the larva, with the mouth of the shell upwards, moves through the water with lively action, sinking, or rising, or advancing onwards at its pleasure."

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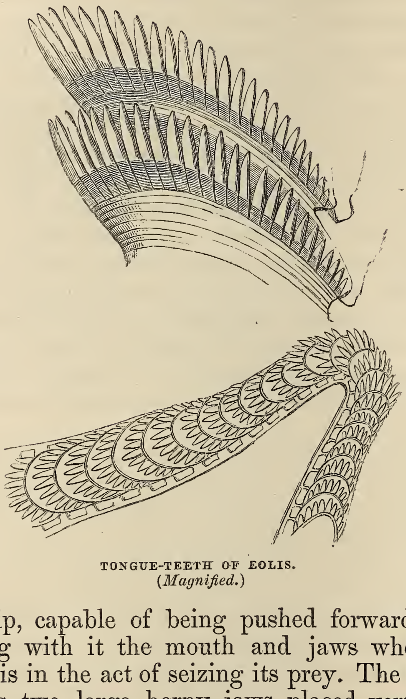
* Alder and Hancock's Monograph. (Doris.)

Messrs. Alder and Hancock, from whose beautiful "Monograph of the British Nudibranchiate Mollusca" I cite these particulars, "have not succeeded in tracing the development of the larva into the mature form; but it is not difficult to understand how this change is effected. When the larva is placed with the mouth of the shell downwards, the oral lobes in front, (speaking particularly of *Eolis*,) the anal termination of the intestine, and the oval sac representing the generative organs, will be found on the right side, close to the base of the oral lobe, and the operculigerous lobe or foot will be seen to extend backwards in a median position, occupying the place of the crawling disk. Thus it is evident that the principal organs of the larva only require to be slightly modified in form, and it is changed into the mature animal, the shell and operculum being cast off, and the oral lobes either absorbed or altered into a veil or oral tentacles."

The food of the Nudibranch Mollusca is for the most part animal. Various kinds of zoophytes are devoured by many species, some are even cannibals, preying upon their own kind; but some of the *Dorides* appear certainly to be herbivorous, feeding on the fronds of sea-weeds. Professor Grant has often found their stomachs completely filled with minutely divided portions of coarse marine plants, filling not only that organ, but also the cavities of the liver, which in these animals is very large. The mouth and its various parts are very efficiently adapted for the seizing and devouring of food. Various parts are armed with points and cutting edges in different genera; but the tongue is, I believe, in all most elaborately armed with spinous teeth, arranged in numerous rows.

The mouth has large fleshy lips prolonged into an internal tube, within which is a muscular inner lip, capable of being pushed forwards, and bringing with it the mouth and jaws when the animal is in the act of seizing its prey. The mouth contains two large horny jaws placed vertically, and armed with cutting edges. The tongue is shaped like a strap, and can be moved in different directions, or thrown forwards to assist the animal



TONGUE-TEETH OF EOLIS.
(*Magnified.*)

in seizing and securing its prey. It is covered with numerous transverse plates, armed with spines or teeth directed backwards. These teeth differ in number and in form; those of *Eolis papillosa*, figured above, are very numerous and minute, being not more than one-sixth part of the thickness of a human hair. Their arrangement is in transverse arched rows, but in *E. coronata*, there is one large central tooth on each plate with denticulated sides; and in *E. alba*, a central tooth only, without denticulations.

FAMILY DORIDIDÆ.

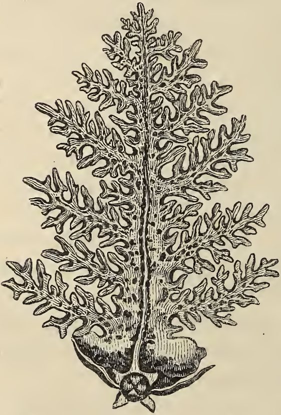
The members of this extensive family are characterised by having the anal orifice placed in the medial line of the back, towards the hinder part, and the respiratory organs arranged around it in a more or less complete circle of leaf-like plumes, so as to resemble the petals of a beautiful flower. The mouth is a small conical proboscis placed under the front edge of the mantle, where this latter organ is distinct, and sometimes guarded by two simple tentacles; another pair of tentacles is placed on the front part of the back. These are peculiar in their structure, being beset with numerous narrow plates, arranged diagonally, parallel to each other. These tentacles, for the most part, are capable of being withdrawn into proper cavities, the edges of which, in many cases, are raised into tubular sheaths to protect them.

The *Dorididæ* are found on the shores of every sea. Many species are common on our own coasts, crawling on sea-weeds, or concealed beneath stones between tide-marks; some kinds, however, confine themselves to deep water, and are to be obtained only by dredging.

GENUS *DORIS.*

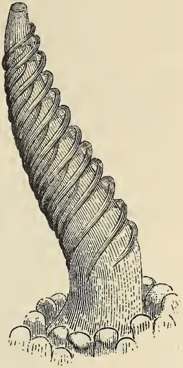
The body in this, the principal genus, is usually of a semi-oval form sometimes very convex, but more generally depressed, and occasionally almost flat. The mantle is ample, projecting over the head, and on all sides; its surface is generally rough, with numerous warts, and its texture is stiffened with calcareous spicula or crystals of lime imbedded in its substance. The mouth is commonly without jaws, but is frequently furnished with a prehensile collar, armed with minute spines. The tongue is covered with rows of teeth curved backwards.

The breathing organs consist of flat plumes, sometimes small and simple, sometimes large and branching, either united at the base into a flower-like expansion, or placed separately in a circle more or less perfect. In some species these plumes are capable of being withdrawn into a common cavity, the margin of which can be closed completely over them, but in others there is no cavity; and when danger threatens, the plumes are merely contracted, curled up, and bent down towards the centre of the circle.



BRANCHIAL PLUME OF DORIS.

The upper or dorsal tentacles are generally short club-shaped organs, with the upper portion frequently bent into an angle. This portion is always set with narrow, oblique plates, usually ten or twelve in number, pointing behind and downward. They are always retractile, but for the most part not sheathed.



TENTACLE OF DORIS.

The species of this genus deposit their spawn in the spring; the eggs, as already described, being generally arranged in transverse rows, imbedded in a transparent gelatinous ribbon. *Doris bilamellata,* which I have kept in captivity, always deposited its ribbons on the side of the vessel just beneath the surface of the water. It adheres by one edge, and forms an imperfect spire or cup, the ribbon being bent upon itself, the upper edge or brim leaning a little outward, and being puckered. That of *D. tuberculata* is very large, the ribbon being three-fourths of an inch high, and wound round in many spiral coils. I have observed it, on the Devonshire shores, depending in a flaccid manner from the under surface of rocks, during the recess of the tide. The embryos in such coils of spawn are immensely numerous. Mr. Darwin thus describes the contents of a spawn-coil of a species of this genus, which he found at the Falkland Isles. "From two to five eggs [yolks], each $\frac{3}{1000}$ths of an inch in diameter, were contained in a spherical little case [*chorion*]. These were arranged, two deep, in transverse rows, forming a ribbon. The ribbon adhered by its edge to the rock in an oval spire. One which I found measured nearly twenty inches in length, and half in breadth. By counting how many balls were contained in a tenth of an inch in the row, and how many rows in an equal length of the ribbon, on the most moderate computation there were six hundred thousand eggs. Yet this Doris was certainly not very common; although I was often searching under the stones, I saw only seven individuals."*

When we meet with accounts like this of the exceeding multitude of eggs produced by some species of animals, we are apt to wonder that the world is not filled with them, and to ask what becomes of these immense hosts. The fact is, they form the food of other creatures, a vast multitude—perhaps nine out of every ten—being devoured as soon as they are born. What Mr. Peach says of these very embryos, I have myself often observed in those that I have endeavoured to rear. They "have myriads of enemies in the small *Infusoria*, which may be noticed with a powerful microscope hovering round them, and ready to devour them the instant weakness or injury prevents their keeping in motion the cilia, which serve both for locomotion and defence. Let them cease to move, a regular attack is made, and the animal is soon devoured; and it is interesting to observe several of the scavengers sporting in the empty shell, as if in derision at the havoc they have made."†

The largest British species of this genus is *D. tuberculata*, often called the Sea Lemon. It attains three inches in length, is of a yellow colour, with the mantle covered with small round warts. Hence in size, form, hue, and surface, the animal bears no small resemblance to the half of a lemon cut through lengthways, especially when the branchial plumes and the dorsal tentacles are concealed by being withdrawn into their respective cavities. But the colour is not always plain yellow; it sometimes verges to grey, and is frequently marked in the most beautiful manner with large spots and clouds of crimson or purple. The branchial flower is composed of eight plumes, which are large, tripinnate, and of a bluish white hue.

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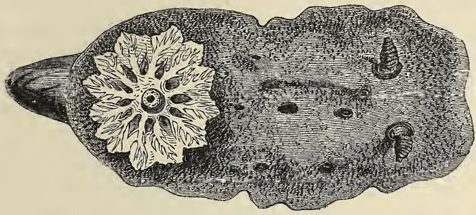
* Voyage of Adventure and Beagle, iii. 258.

† Annals of N.H. xv. 446.



SEA LEMON.

This species is said to be more common on the east coast of Scotland and England than on the west. I have, however, found it on the shores of Dorset and of north and south Devon; it lives among the rocks, in the zone bounded by the limits of high and low tide, as well as in deep water. In captivity, the habit of this, as of some other species of the genus, is to glide slowly round and round the vessel in which it is kept, just beneath the surface of the water, now and then lifting and puckering up the edges of the mantle, and allowing the air to bathe the sides of the body.

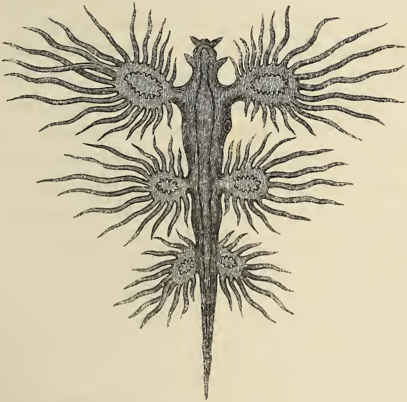
FAMILY TRITONIADÆ.

This is a small group considered in the number of its component species, though some of these are of unusually large size. Its distinctive characteristics are that the gills, which are either laminated, plumose, or papillose, are arranged down the sides of the back, and that the stomach is simple. By the former character it is distinguished from the *Dorididæ*, the feathery gill-leaves of which are retained in several of these, but never arranged in the form of a flower around the vent. By the latter it is severed from the *Eolididæ*, in which the stomach sends off branching tubes on each side.

There is no proper mantle distinguished as such from the general surface of the body; but there is often an elevated ridge running down each side, along which the gill-tufts are placed. In the *Scyllæa*, an oceanic genus found crawling among the stems and weeds of the floating gulf-weed, there are two or three erect, square lobes of flesh, projecting from each side of the back, and on the inner side of these the small tufted gills are scattered. In *Glaucus*, another oceanic animal of exquisite beauty, the gills take the form of fan-like pencils of filaments, diverging from the tips of long foot-stalks.

The head, in most of the species, is protected by a veil or expansion of membrane, sometimes cleft into tentacular processes, at others margined with a fringe. *Tethys,* another beautiful genus inhabiting the Mediterranean, has this veil enormously developed, and profusely fringed. The animal is said to use this organ to aid it in swimming, but this is hardly probable.

So little has been recorded concerning the habits and economy of the marine, and especially the oceanic Mollusca, that I with pleasure quote the observations of Mr. George Bennett, on a species of *Glaucus* taken in the tropical part of the Atlantic ocean. The accompanying figure will convey an idea of the form of the animal, the colour of which is a vivid blue or purple on the upper surface, and silvery white beneath :—



GLAUCUS.

"These little animals were very delicate and fragile in their structure, and although many—indeed I may say numbers—were caught, yet very few in comparison were found to be in a perfect condition, some being deficient in one, two, or more fins, and others being completely crushed. Not one of the specimens caught on this occasion, or during the voyage, had the silvery line or streak running down the back, from the head to the extremity of the tail, branching off also to the fins, and along the centre of each of the digitations. Several *Porpitæ* were also captured in the net at the same time with these animals, and served as food for them.

"It caused much regret to see the change death produced in the beauty of these interesting little animals, and all means of preserving them were found to be useless. When placed in spirits, the digits of the branchial fins speedily became retracted; the beautiful purple gradually faded, and at last disappeared, and the delicate pearly white of the under surface of the body and fins peeled off and disappeared. Thus did this beautiful Mollusk become decomposed in less than the space of an hour. Some Mollusks quickly lose their colour after death, but retain their form for a long time; but these speedily change after death, both in form and colour, and the beauty before so much admired perishes, never to be regained.

"When taken in the hand, the under surface of the animal soon becomes denuded of the beautiful pearly white it previously had, and at that time appears like a small transparent bladder, in which a number of air-bubbles are observed, together with the viscera. On the abdomen being laid open, a large quantity of air-bubbles escaped; and perhaps a query may arise how far they assist the animal in floating upon the surface of the water.

"I again placed several of the specimens in a glass of sea-water; they were full of life, sometimes moving about, not very briskly, however, and at other times remaining floating upon the surface of the water, merely gently moving the fins. As they floated upon the surface of the water in the glass, the sides of the head, back, tail, fins, &c. exhibited at the time a light silvery blue colour, which was admirably contrasted with the deeper blue of the upper surface, and falling into the elegant pearly or silvery white of the under surface of the animal, displaying an exceedingly rich and elegant appearance. Often, when at rest, the animal would drop one or more of the fins; but on touching them, they would be immediately raised to the former position, and that organ was turned back as if to throw off the offending object, followed at the same time by a general movement of the whole body. On touching the animal upon the back, it seemed to display more sensitiveness in that than in any other part of the body, judging from the effects produced in comparison with similar experiments on other portions of the body. For instance, the centre of the back was touched lightly and rapidly with a feather, which caused the little creature to sink, as if under the pressure of the touch, throwing at the same time the head, tail, and all the fins upwards, followed by a general distortion of the whole body of the animal. As if the gentle touch had been productive of severe pain, I invariably found every part of the upper surface of the body very sensitive when touched, displaying a general movement of uneasiness throughout the whole of the body of the creature.

"These creatures have a peculiar manner of throwing the head towards the tail, and flouncing the tail towards the head, when they are desirous of removing any object of annoyance; it is at that time these animals seem to recover from their torpidity, and evince the greatest activity in their movements. When much annoyed, they throw the body about with great activity, coiling up the head, tail, fins, &c. in a somewhat rotundiform position, and if the tormenting object is not removed, dash out again in full activity of body, then return to the rotundiform position, and there remain for a short period, apparently exhausted by their efforts; but on the cessation of the irritating cause, the animal quietly resumed its original position, perhaps dropping one or two of its wearied fins, according as its own sensations of ease or comfort might dictate.

"When nothing irritated this tender Mollusk, it would remain tranquilly floating upon the surface of the water, with scarcely any movement but that which proceeded from the undulating motions of the digitated extremities of the fins, as well as an occasional slight twisting action of the same organs.

"I placed some small specimens of Porpita in the glass of water containing the Glauci, to observe if they would attack them. For some time one of the Glauci was close to a Porpita, and was even annoyed by the tentacles of the latter touching its back; yet the Glaucus bore this, although with the usual characters of impatience, yet without attempting to attack it. At last it seized the Porpita between its jaws, and by aid of a powerful lens, an excellent opportunity was afforded me of closely watching the devouring process, which was effected by an apparently sucking motion; and at this time all the digitated processes of the fins were floating about, as at other times, when the animal was at rest. But I did not observe, in one single instance, that they were of any use to the animals, either to aid in the capture, or to securely hold their prey when in the act of being devoured; for the animal seems to depend merely upon the mouth in capturing its prey, as, in this and other instances which I had opportunities of observing, they seized their prey instantly with the mouth, and held it by that power alone, whilst by a kind of sucking motion the prey was devoured. The digitations may, therefore, only be regarded as appendages to the fins, to aid the animal, perhaps, in the direction of its movements, as it was observed that they turned and twisted them about during the progressive motion—that is, when this tardy animal is pleased to progress,—as if in some way or other to direct the movements of the animal.

"The Glaucus, after eating the tentacles, and nearly the whole of the soft under surface of its prey, left the horny portion, and remained tranquilly reposing upon the surface of the water after its meal, the only motion visible in the animal being the playing of the digits of its fins. The mutilated remains of the Porpita sank to the bottom of the glass.

"Soon after, another Glaucus began a devouring attack upon another Porpita which had been placed in the glass, eating a little of it, and then ceasing after a short meal, occasionally renewing the attack at short intervals. On examining the Porpita which had been partially devoured by the ravenous

Glaucus, I found the disc had been cleared of the tentacles and other soft parts, a small part of the fleshy portion only remaining upon the disc. Only one part of the horny disc exhibited any injury, and that appeared to be the place where the animal was first grasped by the Glaucus.

"When any of these animals came in contact with another in the glass, they did not display any annoyance, nor coil themselves up, nor did they evince any savage propensities one towards the other; and they would often float about having their digitated processes in contact one with the other, without exhibiting any signs of annoyance. Even when placed or pushed one against the other, they did not manifest any irritation, but remained undisturbed as in their usual moments of quiet repose.

"On the back of the animal being seen in a strong light, a black line could be discerned on each margin, and passing down the centre of each fin; and sometimes varied by having two black lines on the upper part of one fin, although the opposite fin may display but one.

"The margin between the falling of the purple colour of the back into the silvery white of the abdomen, often exhibited beautiful tints of a golden green; but these variations were probably produced by the effect of different rays of light. These animals soon perished; I could not preserve them for any length of time in the glass of sea-water, although the water was changed as often as it was thought necessary. The digitated processes of the fins were observed to shrink up on the death of the animal, and the process of decomposition rapidly took place, the whole body becoming a shapeless mass, having a bluish colour of deadly hue for a short period, and then becoming of a blackish or brownish black colour. I have seldom seen a gelatinous animal which appeared so firm whilst in the water, that proved so speedily to decompose when removed from it. Even the beautiful purple of the back, the silver or enamel of the abdomen, and the silvery blue of the sides, all speedily vanish, indeed instantly disappear, upon the death of the animal, as if it had been washed off; the expansive, delicate, and beautiful fins, and digitated processes, are no longer seen; they shrink up to nothing.

"Even on taking the animal alive out of the water, and placing it upon the hand, that instant almost, from its extreme delicacy, it was destroyed. The digitations of the fins fell off, the least movement destroyed the beauty of the animal, it speedily lost all the purple and silvery enamelled tints, and became a loathsome mass. Thus do we too often find animals, beautiful in external adornments, curious in their habits and organization, and calculated in every respect to supply us with inexhaustible sources of intellectual gratification, doomed speedily to perish—brief in the period allotted to them in the busy theatre of animated existence: but, doubtless, with the gift of existence, they have received from the bounteous hand of their Creator, the means of enjoying their fleeting lives.

"To place these little animals in the glass of water from the towing net, without injury to their delicate structure, required care; so that as soon as they were captured in the net, attached to the meshes, they were not handled, but carefully washed off, which was effected by dipping the meshes in the glass of water, when the animal soon detached itself without sustaining any injury, and floated in the water.

"Although these animals are so fragile, so easily destroyed on being taken out of their natural element, yet they fling themselves about in the water without sustaining any injury, without even the loss of any of the digitated processes of the fins; yet when there is much movement of the water, in carrying the glass from one place to another, they are evidently disturbed and restless, and the fins are dropped. If, therefore, a slight motion of the water disturbs them, what can become of these delicate Mollusks during tempestuous weather? Can they be similar to the delicate ephemera, doomed to live merely for the space of a day, and perish in myriads? From the immense number seen only from the ship,—and how many myriads more extended beyond our range of vision!—it conveyed to the mind some idea of the profusion of living beings inhabiting the wide expanse of ocean, and a feeling of astonishment at the inconceivable variety of forms and constructions to which animation has been imparted by creative power.

"The tail of this animal has been described as resembling that of a lizard. The comparison is good, not only with regard to form, but also (with, perhaps, a little more flexibility) to motion when in action. Sometimes the animal throws its tail up to the body, as if intended to brush off any annoying object, and at other times it has been observed to turn the head towards the side, as if for a similar purpose; it seems in the action of eating to resemble a caterpillar."*

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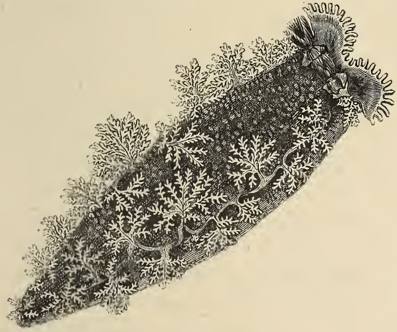
* Proc. Zool. Soc. for 1836.

GENUS *TRITONIA*.

The body is prismatic; that is to say, lengthened with ridges or angles running along it; it is often thick and firm. There are two tentacles, consisting of several branched filaments arranged in the form of a bundle or brush, and capable of being withdrawn into tubular sheaths. The head is protected by a veil sometimes cleft into filaments. The gills are small branching plumes, arranged in a single series along a ridge bordering each side of the back.

The largest British species of the whole Order is a member of this genus, *Tritonia Hombergi*, which grows to six inches or more in length. It varies considerably in colour, being generally of a pink or purple hue, often varied with blue, but sometimes the entire animal is of an amber yellow.



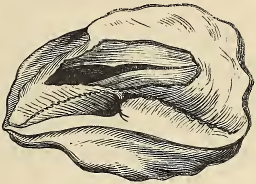
TRITONIA HOMBERGI.

This very fine species occurs all round our coast, but is considered somewhat rare. It seems to be a deep water species: I have procured it by trawling off Portland. It is remarkable for a power possessed only in a very limited degree by any of the Mollusca, that of producing an audible sound.

Professor Grant, to whom we are indebted for a record of the curious fact, says "that the sounds resemble very much the clink of a steel wire on the side of the jar, one stroke only being given at a time, and repeated at intervals of a minute or two. When placed in a large basin of water, the sound is much obscured, and is like that of a watch, one stroke being repeated as before at intervals. The sound is longest and oftenest repeated when the *Tritoniæ* are lively and moving about, and is not heard when they are cold and without any motion. In the dark, I have not observed any light emitted at the time of the stroke; no globule of air escapes to the surface of the water, nor is any ripple produced on the surface at the instant of the stroke. The sound, when in a glass vessel, is mellow and distinct."

The Professor has kept these *Tritoniæ* alive in his room for a month; and during the whole period of their confinement, they have continued to produce the sounds, with very little diminution of their original intensity. In a still apartment, they are audible at the distance of twelve feet. "The sounds obviously proceed from the mouth of the animal, and at the instant of the stroke we observe the lips suddenly separate, as if to allow the water to rush into a small vacuum formed within. As these animals are hermaphrodites, requiring mutual impregnation, the sounds may possibly be a means of communication between them; or if they be of an electric nature, they may be the means of defending from foreign enemies one of the most delicate, defenceless, and beautiful Gasteropods that inhabit the deep."*

The mouth in this animal forms, according to Cuvier's elaborate description, a cutting instrument of peculiar efficiency. "It consists of a large oval and fleshy mass enclosing the jaws and their muscles, as well as a tongue covered with spines, and its opening is guarded by two fleshy lips. The jaws form the basis of all this apparatus. Their substance is horny, their colour a yellowish brown, and their form very extraordinary, for an organ of this kind cannot be better described than by comparing it to the shears used in shearing sheep. They differ, however, in the following particulars: instead of playing upon a common spring, the two blades are formed to work upon a joint, and instead of being flat, they are slightly curved.


MOUTH OF TRITONIA.

"The two blades are very sharp, and there is nothing that has life that they cannot cut, when the animal causes the cutting edges to glide over each other. For this purpose muscles of great strength are provided, the fibres of which are transverse; and their office is to approximate the two blades that are again separated by the natural elasticity of the articulation, whereby they are united at one extremity.

"The aliment, once cut by the jaws, is immediately seized by the papillæ of the tongue, which, being sharp and directed backwards, continually drag by a kind of peristaltic movement the alimentary materials into the œsophagus."*

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* Edin. Phil. Journ. xiv. 186.

FAMILY EOLIDIDÆ.

The animals of this family have a peculiar elegance, delicacy, and beauty. They have the branchiæ arranged along the sides of the back. In one genus, which links this family with the preceding, these organs are branched, resembling little leafless trees; but in general they are warts of a long oval or spindle shape, pointed at the extremity. Their surface is covered with strong cilia, which constantly maintain a vigorous vibration, by the action of which currents of the surrounding water are continually poured along each of the *papillæ,* as these organs are named, affording the necessary oxygen for renewing the vital power of the blood. There is reason to believe, however, that the whole surface of the body, which is also covered with cilia, assists in respiration.

The papillæ are permeated by a canal, which in many of the species is brilliantly coloured, contributing largely to the exquisite beauty of these little animals. This canal is connected with the stomach and the digestive function, supplying the place of the liver in other animals. In the principal genus of the family, each papilla is furnished with a curious organ; it is a little oval bag placed at the extremity of the papilla, and opening by a very minute aperture at its tip. Within the bag there are closely packed a vast multitude of clear oblong capsules, within each of which a narrow body is discerned running through its length. At the will of the animal, a number of these oblong capsules are ejected from the aperture, and at the same instant each capsule shoots forth with great force from one end a long thread or hair. These thread capsules are found in the *Actiniæ* and *Coral* animals, as also in *Medusæ;* and there can be little doubt that they are weapons of defence, and that the propulsion of the thread is the immediate cause of the stinging power possessed by many of these animals; probably, indeed, by all, though not appreciable by us.

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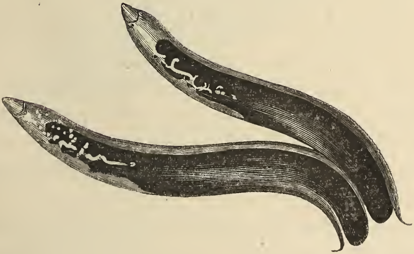
* Jones' Anim. Kingd. 410.

The structure of the mouth and of the tongue with its numerous teeth has been already described.



PAPILLÆ OF EOLIS.

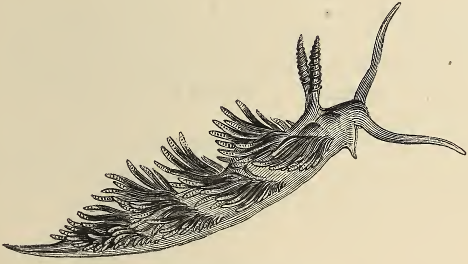
A short gullet leads into a large membranous stomach, sending off on each side branches which subdivide and lead by smaller tubes into the canals, which I have already mentioned as running through the branchial papillæ.

GENUS *EOLIS.*

A vast number of species are comprised in this genus, and nearly fifty have already been discovered on our own shores. Their body is somewhat slug-like, sometimes broad, but more generally slender and much lengthened, without the least trace of a mantle. The skin is smooth, and not stiffened with spicula; the head is prolonged into two smooth tapering tentacles, which are apparently organs of touch, being waved about with great vivacity when the animal crawls; besides these there are two dorsal tentacles, situated as in *Doris.* Their surface is sometimes smooth, but sometimes set with membranous rings or oblique plates; the eyes are placed behind them. The branchiæ are lengthened, cylindrical, spindle-shaped, or flattened papillæ, arranged in transverse rows or clusters along the sides of the back, often very numerous. These organs usually project outwardly, leaving an open space down the middle of the back; they are commonly carried inclining backwards, and overlapping each other; but when the animal is alarmed or irritated, and particularly when it seizes its prey, they are stiffened, erected, and brought forward like the quills of a porcupine.

All the species are carnivorous, fierce, and voracious; some prey upon their weaker fellows, and even devour their own spawn. The ordinary food of most of the species appears to be the various kinds of zoophytes; some of the minuter sorts, creatures of great beauty, are almost invariably found nestling in the tiny shrubs of *Sertularians*, and there can be no doubt that they devour the polypes. Mr. Alder has seen *E. coronata* feed upon a *Lucernaria*, and I have found the largest of our native species, *E. papillosa*, eagerly gnawing the tentacles of *Actiniæ* more bulky than itself.

One of the most lovely of the species is the Crowned Eolis (*E. coronata*), which is scattered over most parts of our rocky shores; I have taken it in considerable number at Babbicombe, Devon, and likewise at Weymouth, clinging to the under surface of flat stones at extreme low water. When the stone is turned over, an inexperienced collector might readily overlook it, for it takes the appearance of a shapeless knob of jelly about as large as a pea. On detaching it, however, and dropping it into a glass of clear sea-water, its beauty becomes apparent. It quickly unfolds itself into a slender, tapering animal, about an inch long, and of a clear pellucid appearance, tinged with pink. The papillæ are arranged in six or seven clusters on each side; they are slender, with the central canal of a rich crimson hue, the surface reflecting a brilliant metallic blue, and the tips opaque white. The tints of these organs are exceedingly beautiful; and as the animal



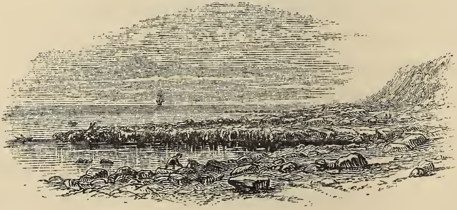
THE CROWNED EOLIS.

moves them irregularly about, they shine with a radiance resembling that of rubies and sapphires.

These elegant branchiæ seem very easily dislodged; the specimens I have kept have usually lost one or more tufts, which, however, soon begin to sprout again. They are liable to be lost through the pugnacity of the animals themselves, as their predaceous habits frequently impel them to tear off each other's papillæ.

In captivity, this Eolis is very active, continually gliding with a uniform motion around the sides of the vessel, or climbing about the numerous branching sea-weeds that are growing in it. They frequently crawl close to the edge of the water, but never come actually out, though they occasionally float at the surface, by means of the expanded foot, back downwards.

Another species (*E. punctata*) has been heard to make that peculiar clicking sound, already mentioned as produced by *Tritonia*.



ORDER TECTIBRANCHIATA.

(Covered-gilled Mollusks.)

In general form and appearance, many of the animals contained in this Order resemble those of the preceding; but they differ from them in having the gills attached along the right side, or upon the back. These organs assume the form of a single plume, or of leaflets more or less divided, but not symmetrical; they are always more or less covered by the mantle, whence the name applied by Cuvier to the Order. The mantle encloses within its substance, in almost all cases, a small shell to protect the vital parts. In some of the genera, the shell is developed to such a degree as to cover the animal; as in the fresh-water limpet (*Ancylus*), found in some of our streams. For the most part, however, the species are marine; they are widely scattered, but appear to be most numerous in the Indian and Mediterranean Seas. The sexual functions are united in each individual, in which particular, this Order agrees with those which I have already considered; but in the form of the breathing organs, it manifests a closer affinity with the following Order.

The Covered-gilled Mollusca may be grouped in five families, three of which are represented by British species.

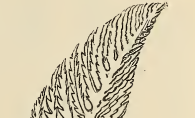
Family Pleurobranchidæ.

The members of this family a cursory observer would at once associate with the *Nudibranchs;* but an examination of their structure reveals particulars in which we see an evident departure from that model. The mantle is large, projecting on all sides over the foot, which is also ample; thus a deep furrow runs all round between these parts. Within this furrow, on the right side, lies the branchial plume, resembling a series of pyramids, divided into triangular leaflets. The plume is attached to the body at its base, but its tip, which points backwards, is free. The organs of reproduction and of excretion are also situated on the same side, the former before, the latter behind the gill-plume. The head is distinct, concealed by a broad veil, which is furnished with four tubular tentacles. The mouth consists of a simple muscular proboscis, or fleshy tube, which is capable of considerable elongation and contraction; it is entirely destitute of teeth or any cutting instrument, but is, nevertheless, fully able to seize and force into the stomach such materials as are used for food. The stomach is greatly developed, and in the principal genus is divided into four cavities, of which the second is muscular, and armed with shelly teeth; the internal surface of the third is increased by longitudinal plates.

In the typical genus, there is a small thin shell enclosed within the mantle, and situated in the middle of the back, so as to cover and protect the viscera. In the curious genus *Umbrella*, from the Indian ocean and the Mediterranean, the shell is comparatively large, external, and shaped somewhat like that of a Limpet; but in *Pleurobranchœa*, there is no trace of a shell either internally or externally.

GENUS *PLEUROBRANCHUS.*

A not unapt comparison has been made of these Mollusks to a tortoise, the mantle representing the back shield, and the foot the breastplate. They are more or less oval in outline, flattened, with the back convex; the mantle is fleshy, and projects considerably on all sides; the head is placed beneath its front margin, and carries two superior tentacles with a pair of minute eyes, sunk beneath the skin at the outer part of their bases. The upper part of the head is developed into a broad triangular veil, the lateral edges of which carry another pair of tentacles. These organs, as well as the superior pair, are imperfectly tubular, and are formed by the bending together of their sides, which meet and overlap, but do not unite. The mouth is a short, fleshy proboscis, provided with horny jaws and a long ribbon-like tongue, armed with teeth, as in the Nudibranchs. The branchial plume projects from between the mantle and foot; in crawling it is transverse, and appears, when viewed from above, to be composed of many triangular laminæ, overlapping and pointing backwards. Each lamina shows transverse wrinkles. Viewed laterally, it is seen to consist of a central stem, with about eighteen pinnæ on each side, each pinna being again pinnated on each side The stem.



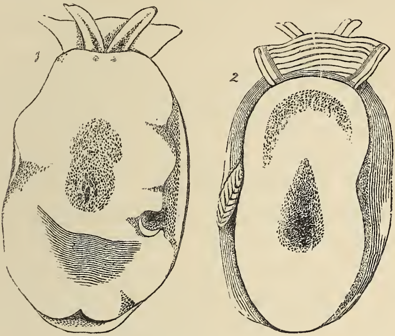
GILL-PLUME OF PLEUROBRANCHUS.

pinnæ, and pinnulæ, are all dilated inwardly, so that the stem, which is narrow and slender in one aspect, is wide in another; and the pinnæ are the triangular laminæ, whose wrinkles are in fact the pinnulæ. The organ is connected with the bottom of the lateral groove, for about two-thirds of its length, by a membrane. The plume can scarcely be recognised in its two aspects, even though examined again and again in quick succession. It appears very sensitive, and changes much in appearance by its various degrees of contraction and expansion.

The mantle contains in the centre of its substance an oval shallow cavity, within which lies, quite free and unattached, a shield-like shell of the same form, so delicate in its texture as to be almost membranous, with a very slight indication of a spire at one extremity. The position of the shell is indicated externally by a dark cloudy spot in the middle of the back; and on an incision being made in this part, the shell falls out.

The warmer seas produce the largest and most beautiful species of this genus, some of which are marked with bright colours. They are found swimming in the open ocean, and crawling on the rocks or weeds of the coast, and specimens have been dredged, from various depths to thirty fathoms, on stony bottoms and beds of sea-weed. We have two native species, neither of which can be considered common. The rarer of these, *Pleurobranchus plumula*, is found on our south-western coast, where it was first discovered by that eminent zoologist, Colonel Montagu. I had recently the good fortune to find two specimens in a rocky cove near Torquay, both of which lived in captivity for some weeks.

The species is usually described as yellowish white; but my specimens were both of a rich golden yellow, with the central cloud brown, tinged in front with red, the underside of the foot of a light flesh colour. The length of the larger was an inch and two-thirds when crawling, the breadth three quarters of an inch.



PLEUROBRANCHUS PLUMULA.
(1. *Viewed from above;* 2. *from beneath.*)

In captivity they were sluggish, fond of hiding among the fronds and leaves of sea-weeds, but at times gliding freely like a *Doris.* They swam on the surface by the foot reversed, and then left behind a great wake of clear viscid jelly. They were beautiful animals. After keeping them in health about a fortnight, I put one into fresh water to kill it, for preservation. This, however, was not so readily fatal to it as I had supposed, for at the end of half an hour I found, by its contraction when touched, that it was still alive. Probably the mode in which it had contracted, on being put in—the foot being narrowed, and the edges of the mantle being incurved on all sides around the foot—may have in some measure prevented the access of the water to the vital parts. At the end of that time I replaced it in sea-water, where it soon partially recovered its activity, relaxed its mantle, and contracted it dorsally so as to expose the groove between it and the foot, greatly protruding the tentacles and veil, and the branchial plume; thus I was enabled to get a much better sight of these parts. As soon as it was replaced in the sea-water, a quantity of white mucus was discharged from the whole surface, most copiously from the foot, which as it lay on its back was uppermost. This mucus gradually, by the contractions of the animal, was accumulated in a knob at the posterior end of the foot, and then thrown off. The reticulate structure of the mantle integument was much more distinct than in health; it was seen to form a delicate lacework of yellow fibres all over the surface, covering and enclosing a pellucid parenchyma.

The animal evidently had been injured by its bath of fresh water; for it lay on its back, expanding and contracting its various parts, without the power of turning over to crawl, or even of adhering by the foot when turned, but rolling helplessly back. The form and appearance, too, were very different from those of health; the groove being widely exposed by the contraction of the mantle, in which state the animal resembled some published representations of it more closely than when in health.

The student of nature, one who really delights to contemplate the wonderful works of God, as they appear in the conditions and under the circumstances in which He has placed them, and not merely their dried and shrivelled remains, technically labelled and arranged in the drawers of a cabinet, can scarcely have a greater treat than a ramble on a summer's day along the margin of the sea, on some one of our rocky shores.

"'Tis pleasant to wander along on the sand,
Beneath the high cliff that is hollow'd in caves,
When the fisher has put off his boat from the land,
And the prawn-catcher wades thro' the short rippling waves;

While fast run before us the sandling and plover,
Intent on the crabs and the sand-eels to feed;
Or on a smooth rock which the tide will soon cover,
To find us a seat that is tap'stried with weed."

But still more pleasant is it to peer into those wells of pure water which are hollowed out in the living rock, fringed with waving sea-plants, and stocked with animals of various kinds, all pursuing their natural avocations, and disporting themselves in a thousand ways, under the umbrageous shade of what to them is a marine forest. As we gaze down into these clear, quiet depths, we almost unconsciously repeat the words of one of our noblest poets, who has selected such a scene for the embellishment of the wildest of his romances:—

"And here were coral-bowers,
And grots of madrepores,
And banks of sponge, as soft and fair to eye
As e'er was mossy bed
Whereon the wood-nymphs lie
With languid limbs in summer's sultry hours.
Here too were living flowers,
Which, like a bud compacted,
Their purple cups contracted,
And now, in open blossom spread,
Stretch'd like green anthers many a seeking head.

And arborets of jointed stone were there,
And plants of fibres fine as silkworm's thread;
Yea, beautiful as mermaid's golden hair
Upon the waves dispread.
Others that, like the broad banana growing,
Rais'd their long wrinkled leaves of purple hue,
Like streamers wide outflowing."*

A hundred times might you fancy you saw the type, the very original of this description, tracing, line by line, and image by image, the details of the picture; and acknowledging, as you proceed, the minute truthfulness with which it has been drawn. For such is the loveliness of nature in these secluded reservoirs, that the accomplished poet, when depicting the gorgeous scenes of eastern mythology; scenes the wildest and most extravagant that imagination could paint; drew not upon the resources of his prolific fancy for imagery here, but was well content to jot down the simple lineaments of nature, as he saw her in plain homely England.

It is a beautiful and fascinating sight for those who have never seen it before, to see the little shrubberies of pink coralline,—the "arborets of jointed stone,"—that fringe these pretty pools. It is a charming sight to see the crimson banana-like leaves of the *Delesseria* waving in their darkest corners; and the purple fibrous tufts of *Polysiphoniæ* and *Ceramia*, "fine as silkworm's thread." But there are many others which give variety and impart beauty to these tide-pools. The broad leaves of the *Ulva*, finer than the finest cambric, and of the brightest emerald-green, adorn the hollows at the highest level; while at the lowest wave tiny forests of the feathery *Ptilota* and *Dasya*, and large leaves cut into fringes and furbelows, of rosy *Rhodymeniæ*. All these are lovely to behold; but I think I admire as much as any of them, one of the commonest of our marine plants, *Chondrus crispus*. It occurs in the greatest profusion on our coast, in every pool between tide-marks, and every-where,—except in those of the highest level, where constant exposure to light dwarfs the plant, and turns it of a dull umber-brown tint,—it is elegant in form, and brilliant in colour. The expanding fan-shaped fronds, cut

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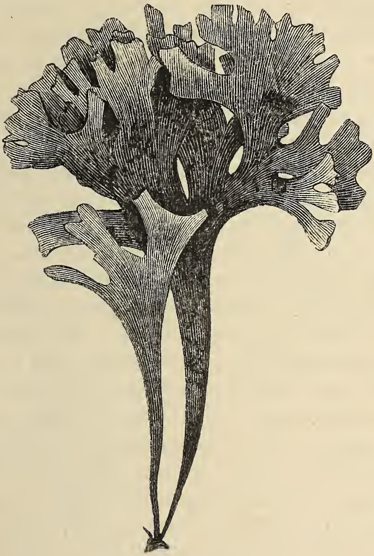
* Southey. Curse of Kehama, xiv. 5.



CHONDRUS.

into segments, cut, and cut again, make fine bushy tufts in a deep pool, and every segment of every frond reflects a flush of the most lustrous azure, like that of a tempered sword-blade.

I have said that animals of various kinds inhabit these rock-pools. They are cavities of irregular shapes and diverse dimensions in the surface of the rock, covered by the sea at every incoming tide, and left full when it recedes. The water, therefore, presently becomes as clear as crystal, and the surface being too small to be ruffled by ordinary breezes, the eye can easily penetrate even to the bottom, and mark all that is going on within. There are little fishes, with bright eyes and silvery sides, peeping from under the shelter of the broad leaves, or darting out with vibrating fins from beneath one projection of the rock to another. Elegantly painted prawns are swimming leisurely to and fro, and hundreds of other smaller Crustacea are playing about. Sea anemones of different species stud the rocky sides, and attract the eye with their brilliant colours—crimson, purple, scarlet, green, and white—resembling gorgeous flowers, or ripe and mellow fruits, according as they are expanded or contracted. The shelled Gasteropods are not wanting; the little Cowry, the *Purpura*, the various species of *Trochus*, to say nothing of limpets and periwinkles. And here we may often see the lovely Nudibranchs and Tectibranchs, crawling with graceful elegance about the fronds of the waving Algæ, or floating at the surface of the still water in that reversed position already described.

Many more objects of like kind the observant naturalist will find from time to time, to gratify his curiosity and reward his diligence; twining Sea-worms and Star-fishes; little Medusæ, like active bells of the clearest glass; the Beroë, a tiny ball of crystal; slender, shrub-like Zoophytes; and multitudes of other creatures, all shewing forth the glory of the great Workmaster, "for whose pleasure they are and were created." (Rev. iv. 11.)

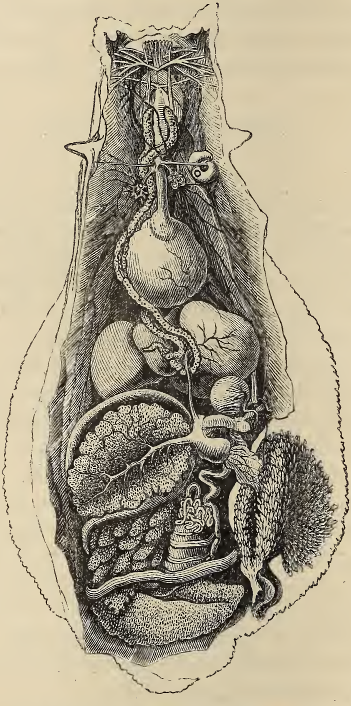
FAMILY APLYSIADÆ.

(*Sea-Hares.*)

In such rock-pools as I have just described, or among sea-weeds growing at low water-mark, a large fleshy Mollusk may occasionally be found, with two erect tentacles somewhat resembling the ears of the hare. It is the representative, the only British one, of the family *Aplysiadæ.*

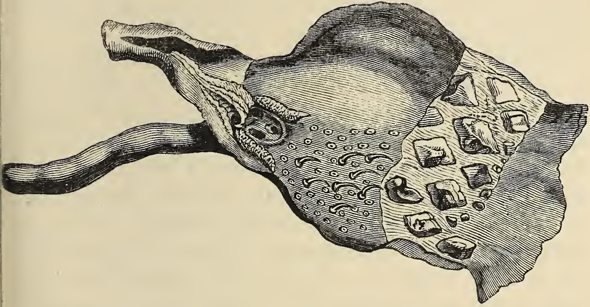
The most prominent characteristics of this group are the following:—The mantle is greatly developed and dilated at the sides into large flexible crests, which can be turned up, and, surrounding the back on every side, can be reflected over it. The head is distinct, and separated from the body by a neck of greater or less length; its front forms a broad lip, drawn out at the corners into a pair of flattened tentacles; another pair is carried erect on the top of the head. The gills, in the form of complicated leaflets, are placed upon the back, and are generally covered with a convex, horny, or shelly plate, irregular, and varying in shape.

The Sea-hares are vegetable feeders, and, by a curious analogy with the herbivorous Mammalia, the digestive apparatus is highly complicated. According to Professor Grant, there are three stomachs; a short narrow gullet dilates into a large membranous crop; a curved bag, which is generally found filled with pieces of coarse sea-weed. This large crop or paunch occupies the right side of the



INTERNAL ANATOMY OF SEA-HARE.

body, and opens laterally into the middle stomach, which is the smallest of all, and performs the part of the gizzard. Its coats are thickened; and the interior callous lining is beset with firm, horny processes, in the form of rhomboidal plates or molar teeth, which serve to compress the softened vegetable matter transmitted in small portions from the first stomach. The third cavity of this complex apparatus is placed on the left side of the body; its interior surface is studded with sharp, horny spines, resembling canine teeth, to pierce and subdivide the coarse food, and thus prepare it for the action of the gastric juice, and other fluids accessory to digestion, which enter the stomach from adjacent organs.



SECOND AND THIRD STOMACHS OF SEA-HARE LAID OPEN.

The complexity of this structure has reference to the coarseness of the materials on which the animal subsists—the leathery fronds of the olive sea-weeds, which slowly and with difficulty yield their nutritive elements to the digestive functions.

The circulation of the blood in these animals has been considered, on the high authority of Cuvier, to present extraordinary peculiarities. The large vessel which collects and receives the venous blood from all parts of the system, and carries it forward to the gills, was believed to have numerous perforations in its walls, through which a free communication existed with the general cavity of the abdomen, so that the fluids contained in the one could readily permeate the other.* But it has been since proved that these supposed perforations are merely depressions, and that the lining membrane of this great blood-vessel is entire, as in other animals.†

The Mollusca of this Order undergo a metamorphosis exactly similar to that already described in the Nudibranchs; there is, in fact, scarcely any appreciable difference in the form of the newly-hatched young in either of these Orders, in that of the *Pectinibranchs*, and in the Class *Pteropoda*. How long the infant animal remains in this, its first condition, is not yet ascertained. Arrived at the second stage, we find it still enclosed in its transparent and nautilus-like shell; but the mantle has become detached, and covers tightly the mass of the viscera. The foot is so enlarged, that it forms a considerable projection beyond the margin of its operculum; and the veils have also grown in size, while the eyes have altered to a violet colour. The head has now two short, conical, ciliated tentacles, and the little animal swims with surprising quickness.

In the third stage the shell has fallen off, and the general shape is that of the parent, but the veils still remain. In the fourth stage, the creature begins to crawl in the gasteropod fashion, and the branchiæ and cæca begin to sprout. There are now, also, visible pulsations in the heart; and the mouth is armed with jaws, and with a spinous tongue. Another stage is marked by the fall of the veils, and by the budding forth of the anterior tentacula, as well as of the branchiæ; and the full evolution of these organs completes the metamorphosis and entitles the animal to the privileges of maturity.*

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* Mem. sur les Mollusques, ix. 14. † Grant's Comp. Anat. 465.

GENUS *APLYSIA*.

Most of the characters which distinguish this genus have been already enumerated in those of the family. The peculiarities by which it is separated from its fellow genera are chiefly the presence of an internal shell, and the position of the gill-plume. The latter organ assumes the form of complex leaflets, attached to a broad membranous footstalk, and concealed beneath the shell.

The genus is truly marine; yet M. Rang has observed specimens of *A. dolabrifera* inhabiting marshes in the island of Bourbon, where the water was almost fresh, and where *Neritina* and *Melania*, both essentially fresh-water genera, were its companions.

They swim freely, by means of the large fin-like expansions of the mantle, which are waved with an undulating motion. They have been seen also floating at the surface, suspended like Pond-snails from the inverted foot.

All the species, I believe, are remarkable for the power of pouring out, in copious profusion, a fluid of a brilliant purple hue, which readily diffuses itself through the surrounding water. I have already mentioned my own experience of this phenomenon in a West Indian species, and Mr. Patterson thus speaks of it in our native species, *A. hybrida*. "The first which our dredge brought up was placed on one of the rowing benches of the boat, and in a very short time emitted a rich purplish fluid, so copiously, that it ran along the board. Being transferred to a phial of sea-water, the purple dye was still given off in such abundance that the creature soon became indiscernible. It was not until the water was again changed that we had the opportunity of observing the ease and grace with which it moved about, elevating and depressing its mantle, altering the outline of its body, and extending and retracting its tentacula so incessantly, that an artist would have found a difficulty in catching its characteristic figure."* This fluid is said by Professor Goodsir to be secreted by the edge and internal surface. The secreting surface of the mantle consists of an arrangement of special nucleated cells, which are distended with a dark purple matter.†

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* Johnston's Introd. to Conchol. 373.

Besides the purple secretion, the Sea-hares occasionally discharge, from an orifice situated behind the oviduct, a milky fluid highly acrid, and probably containing stinging thread capsules similar to those already described in *Eolis*. The Sea-hares have in all ages sustained the imputation of being highly offensive and injurious to man, and though in modern works it has been the custom to ridicule the charge, there is reason to think it may not be altogether groundless. Barbut declares that a sailor, in the Mediterranean, happening to take hold of an Aplysia, it gave him such instantaneous and excruciating pain, as to cause inflammation and the loss of his arm. A better authority, Mr. Charles Darwin, found a species at St. Jago, the secretion from which caused a sharp stinging sensation similar to that produced by the *Physalia* or Portuguese man of war.*

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* Zool. for Schools, i. 179. † Anat. and Pathol. Obs. 23.

The account given by Bohadtch is remarkably clear and circumstantial. He tells us that the Lernæa (*A. leporina*) abounds in the Bay of Naples, where the fishermen excused themselves for not bringing it to him, saying it was a filthy thing which stank abominably. When removed from the sea, and placed in a vessel, there exuded a large quantity of a limpid, somewhat mucilaginous fluid, exhaling a sweetish, sickening, peculiar smell: but besides this, and distinct from its purple secretion, the Aplysia excretes also a milky liquor, formed in an internal conglomerate gland, which seems to be analogous to the kidney of vertebrate animals. As often as he took the Aplysia from the vase of sea-water, and placed it on a plate with the view of more narrowly examining its structure, the room was filled with a most fœtid, nauseous odour, compelling his wife and brother to leave the room, lest sickness and vomiting should follow. He himself could scarcely endure it, and during the examination had repeatedly to go out and breathe a purer air. His hands and cheeks swelled after handling the creature for any length of time, and as often as it ejaculated its milky secretion; but he is uncertain whether the swelling of the face proceeded from the halitus merely, or from having accidentally touched it with the hand besmeared with the liquid: probably the latter was the real cause, for when he purposely applied some of it to the chin, some hairs fell from the part.*

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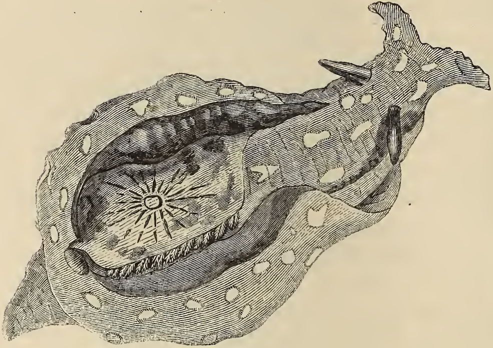
* Voy. Adv. and Beagle, iii 6.

For myself, however, I can state, that I have freely handled many specimens of *A. hybrida*, both young and adult, when newly taken out of the water, without perceiving the least unpleasant sensation, either of feeling or smell.

Among the ancient Romans, the Sea-hare was esteemed highly venomous, and it certainly formed one ingredient in the poisonous draughts that were used in the corrupt ages of the empire for the vile purpose of assassination. Locusta used it to destroy such as were inimical to Nero; it entered into the fatal potion which she prepared for the tyrant himself, and which he had not resolution to swallow; and Domitian was accused of having given it to his brother Titus. To search after the Sea-hare was to render one's self suspected; and



SEA-HARE.

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* De Anim. Marin.

when Apuleius was accused of magic, because forsooth he had induced a rich widow to marry him, the principal proof against him was that he had hired the fishermen to procure him this fearful animal. He averred, however, that his only object in procuring the Sea-hare was the gratification of a laudable curiosity.

Our native species (*A. hybrida*) is about three inches in length, of an olive or dark green hue, often marked with dark rings enclosing white areas; the mantle is sometimes clouded with purple or blue.

FAMILY BULLADÆ.

The shell, which in the preceding families is thin, small, and rudimentary, is in this family much more developed. The spiral character is distinct, and the general form and texture show a considerable approach to that condition in which it is more familiar to us, viz. that of an ample, turbinated covering, for the inhabitation of the animal, of stony hardness. Yet in none of the genera of this family does the shell perform the function of a dwelling-house for the animal: it is still more or less concealed by the flesh; not, indeed, imbedded in the substance of the mantle, but invested more or less completely by fleshy lobes or wing-like expansions, that turn up on each side and embrace it. In the genus *Scaphander*, however, which includes the largest British species of the family, the shell is entirely exposed, the wing-like lobes being smaller than usual.

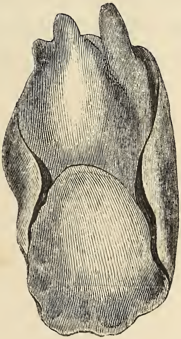
In its texture the shell is generally thin, pellucid, and colourless, or nearly so, though in some of the species in which the family characters are beginning to disappear, pale colours are displayed by the shell, and its texture is stony. Its form is more or less rolled upon itself, but without a salient or produced spire, and the mouth is usually ample and widely expanded.

The animal is large, fleshy, and often slimy. The gills are concealed, the tentacles are so much shortened, widened, and separated, that their form is well-nigh obliterated, and they constitute a large square fleshy veil, beneath which are placed the eyes. The stomach is complicated, and in some species there is a shelly gizzard, with a peculiar grinding apparatus of great strength, needful for the demolition of the shells of other species of Mollusca on which the *Bulladæ* feed. They are very voracious, and sometimes swallow bivalves so large as quite to distort their own form, and render it almost unrecognisable. The shelly gizzard of *Scaphander lignarius*, a large species not uncommon on our coasts, was described by Gioeni, a Sicilian naturalist, as a new genus of multivalve shells, to which he gave his own name, calling it *Gioenia.* He even went so far as to describe the habits of the pretended animal, which was actually received into the catalogues of science by some of the most eminent names in conchology, until at length the imposture was detected and exposed.

The animals of this family generally inhabit deep water, that is to say, below the range of low tide. Occasionally, however, they stray within tide-marks.

GENUS *PHILINE.*

In this genus the shell is thin, fragile, and colourless, of a broad rounded outline, with the aperture very wide, and a small spire, frequently concealed. The animal is proportionally large, slug-like, and slimy, with the power of secreting and of throwing off an adhesive mucus in copious abundance. The shell is partially covered by the mouth, the side lobes of which are well developed. The head disk is obscurely four-sided, without eyes or distinct tentacles.



THE GAPING BULLA.

Of the six species of this genus which are found in the British seas, the largest is *P. aperta*, the Gaping Bulla. It is an unpleasing, almost shapeless slug, very soft and slimy to the touch, of an opaque white hue, sometimes tinged with pale orange. Looked at from above, it appears to be composed of four portions,—the square head-disk, the body partly enclosing the shell, and the lobes or wings of the mantle turned up on each side and investing it. It is usually about an inch and a quarter in length, but individuals are found of a larger size.

The shell, on being dislodged, is transparent and colourless, but on drying loses somewhat of its clearness, and becomes of a lustrous white hue. Its surface is smooth, except for the concentric lines, which mark its progressive increase. The aperture is so open as to display the whole interior even to the summit.

The Gaping Bulla is common on our coasts, especially in the south, inhabiting muddy and sandy ground at a few fathoms' depth. I have dredged it abundantly in Weymouth Bay, a mile or two from shore. In captivity it is sluggish, remaining inert at the bottom of the vessel in which it is kept, so as to be an uninteresting subject of observation; added to this it continually secretes and discharges a viscid slime, which stretches through the water in long tenacious strings, and envelopes and distresses any other marine animals which may be its fellow-captives. Some of the Nudibranchs discharge mucus in the same manner; but I know of none that possesses the disagreeable quality to the same extent as this Bulla.

ORDER CYCLOBRANCHIATA.

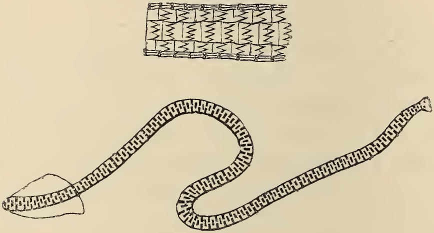
THE breathing apparatus in this small group consists of a great number of little conical leaflets, arranged in a circle, more or less complete around the body, and attached beneath the margin of the mantle. The animal is covered by a shell varying much in dimensions and in structure in the different genera. They are all somewhat sluggish animals, adhering for many hours together to the surface of rocks, or other bodies, by means of the foot, which is large and muscular. All of the species inhabit the sea.

FAMILY PATELLADÆ.

(*Limpets.*)

A conical shell is the distinctive character of this family; showing no trace of a spire, and destitute of any aperture or notch, by which other genera are known, which have shells of similar form and appearance. The shell, which is made out of one entire piece, quite covers the body; it is in the form of a widened cone, the apex of which is higher or lower, nearly central, or more approaching one end,—in different species. The animal is large in proportion to the shell, with a mantle, under the projecting edge of which, is a fringe of small leaves, that perform the office of respiration. The head is furnished with a large but short proboscis, and with two pointed tentacles, each of which carries an eye at the outer side of its base. The mouth is fleshy, and contains a long slender tongue, armed with spinous teeth, for the rasping down of the sea-weeds, of which the food of these animals consists. This organ in the common Limpet is described as a narrow ribbon-like-body, fully three inches long, of nearly equal breadth throughout, except at the tip, where it is soft and somewhat dilated. The width of this singular appendage is not more than one-twelfth of an inch; but the surface is armed through its whole length, with three parallel rows of spinous teeth, pointing backwards. The teeth of the middle row are cut into four points, but those of the external rows, which are not exactly opposite to, or continuous with, those of the middle series, but alternate with them, are cut into two points only.

"The first time," says Mr. Patterson, "we chanced to see this, we mistook it for some strange species of worm; but on examining several Limpets, the supposed worm was seen in all; and great was our astonishment when we discovered that we had, in every case, been looking at the



TONGUE OF LIMPET.

(*The upper figure represents a portion of the surface magnified*).

tongue of the Limpet, and not at any intruder into the privacy of his conical fortress." *

This curiously toothed tongue "is never protruded beyond the margin of the lips. It seems to be used for rasping down the food; and in proportion as the anterior prickles are worn away in this operation, and absorbed, another portion of the tongue is brought forward to supply its place; but that there may be no deficiency in its length, we find the apex soft and vascular, where in fact a continual growth and addition are going on.

"When a phytophagous Gasteropod is about to eat, it thrusts forward, and to a certain extent, evolves, the spinous tongue, protruding at the same time the lip on each side, by which the tongue is compressed and forced into the form of the bowl of a spoon. The food is now taken hold on by the lips, drawn forwards, and retained by the prickly tongue, and simultaneously pressed against the upper horny jaw, by which means a portion is bitten off, sometimes with a very audible noise. The detached morsel is then passed along the tongue, torn and rasped down by its sharp prickles, and forced on by the peristaltic motion of the organ, and by the retropulsive action of the adjacent muscles, the mass is made to enter the gullet. At the entrance of this canal, there is an uvular caruncle, which is probably the seat of the animal's taste; and on its side a pair of lobulated salivary glands, or sometimes two pairs, which have each a single excretory duct to convey their peculiar secretion into its upper part, to lubricate and soften the mass. The gullet is a muscular canal, lined interiorly with a mucous coat, presenting, indeed, the same structure as the whole alimentary canal, and is generally plaited in a longitudinal direction."*

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* Introduction to Zool. i. 178.

M. De Blainville considered that the organ of respiration in the Limpets was a vascular network, spread over the interior of a cavity, situated above the neck, with a wide opening in front. Hence he constituted the family into an order, which he named *Cervicobranchiata*, or neck-breathers. The opinion of so eminent a zoologist, adverse as it was to the received judgment of his fellow labourers in science, demanded a close investigation, which has been given by M. Deshayes and others. The result has been to show that such a cavity exists, with a structure similar to that of the Limpets, in many other *Gasteropoda*, which possess distinct and undoubted gills of the pectinate form, which I shall presently describe; and that there is no sufficient reason for believing that this chamber in the neck has any respiratory function at all: this office being fulfilled by the fringe of floating leaflets that encircle the body, as had been maintained by Cuvier and others.

In order to fit these little organs for the office which has been assigned to them, they are furnished with a multitude of *cilia*, microscopically minute, covering all parts of their free surface. By means of the constant undulating movements of these *cilia*, a perpetual current of sea-water is made to roll along each leaflet, communicating the requisite oxygen to the blood-vessels, of which it is mainly composed. The currents flow from the outer towards the inner edge, across the surface of each leaflet.

* Johnston: Introduction to Conchology, 328.

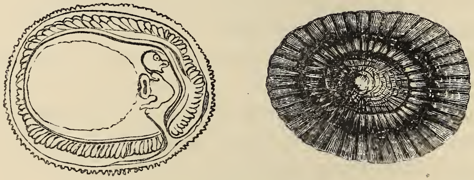
The doubts occasionally cast on what are received as established truths in science, though they may seem to unsettle our knowledge, and give a character of vagueness to it, must not be considered as inimical either to its progress or its solidity; not even when, as in the case just cited, they are found to be without foundation. They give rise to new and more careful examinations; to extensive comparisons of species with species, or of fact with fact; to satisfactory inductions of principles from observations; and often to the discovery of laws before unsuspected.

GENUS *PATELLA*.

As the family consists but of this single genus, the characters already enumerated need not be repeated. The species are numerous, widely distributed over the globe, scarcely any sea being destitute of some, with the exception of the Arctic Regions, where none have been observed by voyagers. As usual, the largest species are found in the seas of the tropics. Deshayes in his Tables enumerates 104 living species, and ten fossil; several others have been added by subsequent naturalists, but as the genus is peculiarly liable to variation in the form, colour, and surface of the shell, it is very likely that many of these described species are merely varieties.

The animals of this genus have the power of wearing away, or of absorbing the surface of other shells, or of the rocks to which they adhere, and of thus forming sunken pits or depressions on them. The *Patella cochlear* of the Cape of Good Hope, is often found attached to a large species of the same genus, on the surface of which it forms a flat disk, exactly agreeing in size with the circumference of its own shell. To form these depressed disks, (of which there are so generally two on each larger *Patella,* one on each side of the apex, as almost to form a character of the species,) and to assist in the increase of its size, the animal appears also to absorb the coralline or other similar substances with which the larger shells are abundantly covered.*

But we need not wander to the southern hemisphere for illustrations of this power. The most familiar shell-fish of our shores, the common Limpet (*P. vulgata*), will afford one equally good. Who has not seen the oval pits, sometimes but just discernible, at others sunk to the depth of an eighth of an inch or more, on the rocks of our coast, each accurately corresponding in shape and dimensions with a Limpet which inhabits it? I have wondered at them many times, not being then aware of the habits which have been ascribed to these animals, of wandering away from these pits, (which they have chosen for a home,) and of returning to them regularly again.



COMMON LIMPET.

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* Gray, in Phil. Trans. 1833.

These habits were first made known by Mr. Lukis, a naturalist of Guernsey, to whom we are indebted for other interesting notes on the economy of animals. "The locomotion of the Limpet," he observes, "may be ascertained by marking one individual to avoid mistake, and then observe its cautious roaming and regular return to its favourite place of rest, where the shell will be found exactly to correspond with the surface of the rock to which it is attached. Here it will rest or sleep, and only relax its strong adhesion to the rock, when the muscular fibre becomes exhausted by long contraction, in which state a sudden blow, horizontally given, will easily displace it. A fact known to the fishermen and poor, who use them for food, is, that they are more easily collected in the night time than in the day. May not this be the period of roaming for food as well as when covered by the tide?

"The march of the limpet is slow and formal; and whenever the cupping process is renewed, the posterior end of the shell is brought in contact with the rock, which is of a soft nature, and will receive the impressions of its denticulations. The track of an individual placed under surveillance was thus made visible over a space of several yards, possessing the same regularity and disposition, and was further remarkable for the constant revolution on its left.

"The tracks of the limpet on granite and other hard rocks, present, at first sight, the same appearances; but, on a closer examination, they are found to differ. When first observed in 1829, a large portion of a fine-grained sienitic rock was traced over by these shells; the remainder was plain, and appeared varnished with a thin coating of some kind of fucus, without any markings upon its surface. As no patellæ were at first discovered, and the isolated situation of the rock prevented any from reaching it, I was at a loss to explain these appearances; but, after some search, a fissure was found at the north end, where five or six limpets had fixed themselves, each having a direct road leading to their pasturage-ground. By the help of a glass, the markings visible on the rock were discovered to be the remains of the above fucus, which had been eaten through or trodden down by these animals in their excursions, and which retained the indentures of their shells. The edge of the vegetable surface was then examined; and found to be nibbled in a circular manner resembling the anterior margin of the shells."*

The force with which a limpet adheres to the rock is very great, especially when it has had warning of assault, and has had time to put out its muscular strength. Réaumur found that a weight of twenty-eight or thirty pounds was required to overcome this adhesive force. His experiments seem to prove, however, that its power is mainly owing, not to muscular energy, nor to the production of a vacuum in the manner of a sucker. If an adhering limpet were cut quite through perpendicularly, shell and animal, the two parts maintained their hold with unabated force, although of course a vacuum, if there had been one, would have been destroyed by the incision. The power is said to reside in a very strong glue, a very viscid secretion, deposited at the will of the animal. "If, having detached a patella," says Dr. Johnston,

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* Mag. Nat. Hist. iv. 347.

"the finger be applied to the foot of the animal, or to the spot on which it rested, the finger will be held there by a very sensible resistance, although no glue is perceptible. And it is remarkable, that if the spot be now moistened with a little water, or if the base of the animal be cut, and the water contained in it allowed to flow over the spot, no further adhesion will occur on the application of the finger,—the glue has been dissolved. It is nature's solvent, by which the animal loosens its own connexion to the rock. When the storm rages, or when an enemy is abroad, it glues itself firmly to its rest; but when the danger has passed, to free itself from this forced constraint, a little water is pressed from the foot, the cement is weakened, and it is at liberty to raise itself and be at large. The fluid of cementation, as well as the watery solvent, are secreted in an infinity of miliary glands, with which the foot is, as it were, shagreened; and as the limpet cannot supply the secretion as fast as this can be exhausted, you may destroy the animal's capacity of fixation, by detaching it forcibly two or three times in succession."*

This common limpet, though hard, coarse, and unsavoury, is largely eaten by the poorer classes on our rocky shores. It is easily procured in almost any quantity, between tides, and therefore is a good deal resorted to by those who have little or nothing better. The wretched inhabitants of the isles of Scotland, and of the Atlantic shores of Ireland, in particular, have often been preserved from actual famine by this miserable food. The quantity eaten as a regular part of diet is immense.

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* Introd. to Conch. p. 147.

Mr. Patterson, when residing, in July, 1837, near the town of Larne, in the county of Antrim, endeavoured to form some calculation of the quantity of limpets alone taken from the rocks about that part of the coast, and used as food. He had reason to believe that the weight of the boiled "fish" was above eleven tons! The weight, as carried from the beach, was, however, much greater, as there was to be added that of the shell, and the sea-water which it contained. This, too, was exclusive of a probably equal quantity of periwinkles and whelks.*

FAMILY CHITONIDÆ.

We find in this family a group of mollusca, which, possessing in their anatomical structure nothing very peculiar, present, in the covering by which they are protected, a form of shell quite anomalous, and such as to have given rise to a conjecture that in this family we have the link that connects the MOLLUSCA with the ARTICULATA.

The shell in the chitons consists of eight narrow transverse calcareous pieces, overlapping each other, and strongly implanted in a thick and fibrous border of the mantle, which surrounds the whole. The mantle itself is of a stiff leathery consistence, and though sometimes smooth, is more commonly covered with small scales, spines, or hairs. The elasticity of this investiture allows the animal to stretch and contract itself in crawling, and even to roll itself in a ball, in the manner of an oniscus or a hedgehog, the shelly pieces moving freely upon each other. To effect the various motions required, there are three muscles given off from each piece to the succeeding one, one in the line of the back, the others at each side. Thus the animal may be considered as enveloped in a coat of plate armour, and the name of coat-of-mail shell is sometimes applied to it by collectors.

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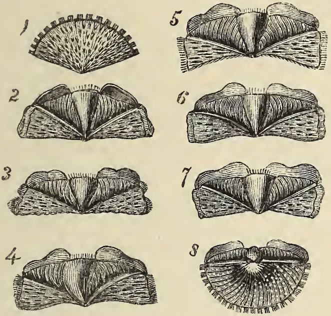
* Introd. to Zool. i. 171.



SHELL-PLATES OF CHITON

The chiton has no projecting head, nor any tentacles, but a kind of veil that surrounds the mouth; the eyes also are wanting. There is a very long ribbon-like tongue, armed like that of the limpet, with horny teeth. The gills consist of small triangular leaflets, set in a fringe, which runs along the furrow between the mantle and the foot. The foot is large, and extends the whole length of the animal.

In the family are comprised two genera, differing in the development of the shelly plates.

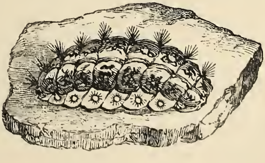
GENUS *CHITON.*

The character which distinguishes the chitons proper from the Oscabrelles (*Chitonellus*), is that the dorsal plates of shell are comparatively large, much wider transversely than longitudinally, and all in contact with, and overlapping each other. This genus includes a large number of species, which are scattered over all seas, except in the very rocky shore, in greater or less abundance, fast adhering by the broad foot, exactly in the manner of limpets. The largest species are found on the tropical coasts of America, where some attain the gigantic dimensions of four, five, and even six inches in length. The *Chiton spiniferus* of Chili is said to reach the size last mentioned. The shells are much prized by conchologists, and they are consequently sought by collectors in foreign countries, though the operation is sometimes attended with danger. I have myself collected some kinds, of large size, on the shores of Jamaica, among sharp and rugged rocks, where the surf dashing in breaks over the naturalist at almost every wave, drenching him, of course, and often buffeting him against the rocks, and washing his prize from his hands the very moment he has detached it from its hold.

The mode in which Chitons are procured requires some skill and practice, as if they are touched without being detached in an instant, they increase their adhesion so greatly as to defy all efforts to remove them without lacerating the edges of the mouth, and thus spoiling them as cabinet-specimens. An old knife, that has the tip blunt and rounded, is the best adjunct. The operator must apply the point of this close to the extremity of the Chiton, without actually touching it; then, striking a smart blow with the palm of his other hand on the handle of the knife, the animal is dislodged by the shock, before it has any opportunity to confirm its hold. To prepare it now for the cabinet, it must be thrown into fresh water for several hours, and when quite dead, which may be known by the relaxation of muscular rigidity, the foot and all the soft parts must be cut out of the concavity of the mantle. The latter must then be placed on a narrow strip of board, exactly as if the animal were crawling, to which it must be tightly bound by threads passed round and round in every part, and laid to dry in the shade. Specimens prepared in this way will possess a natural appearance, and will never curl up in any state of the weather.

The flesh of the larger chitons is red and coarse; it is, however, eaten by the negroes of the West Indies, who compare it, by a certain exercise of imagination doubtless, to beef. There is a species found in the same locality, reported, I know not on what foundation, to be poisonous.

We have about fifteen species of this genus enumerated as British, of which one of the largest, as well as most common, or at least most generally distributed, is the Tufted Chiton (*C. fascicularis*). It is about three-fourths of an inch in length, with the shelly plates striated and granu-



TUFTED CHITON.

lated, and the margin of the mantle studded with little bundles of bristles, about nine or ten on each side. It varies in colour, but is generally greyish, or dusky olive. I have dredged it of large size in Weymouth Bay, attached to oyster-shells. A much smaller species is also common in that locality (*C. cinereus*), which occurs in the pools and on the ledges of the shore, near low-water mark.

When put into a glass of sea-water, the Chitons are sluggish, often remaining for days rolled up before they begin to adhere, and then remaining a long time inert on the same spot.

ORDER PECTINIBRANCHIATA.

(*Comb-gilled Mollusks.*)

We have now arrived at the most numerous division of the Gasteropoda, which comprehends nearly the whole of the spiral univalves, and many with simply conical shells. Their distinctive character is the possession of gills composed of numerous leaflets, or fringes, ranged in parallel order, like the teeth of a comb, and attached, in one, two, or three lines, (according to the genus) to the ceiling of the breathing-chamber, a cavity opening by a wide orifice between the edge of the mantle and the body. All the members of the Order respire water, and nearly all are marine.

A pair of tentacles are always present, accompanied by a pair of eyes, often highly organized, carried, sometimes, on spinal footstalks, and sometimes seated, as it were, on the side, or at the base of the tentacles. The mouth takes the form of a proboscis more or less lengthened, and conceals a tongue armed with small recurved hooks, which wear down the hardest bodies by slow and repeated friction. The sexes are always separate.

The shell is in general *turbinated*, or twisted spirally into a cone more or less regular; the aperture of which is sometimes entire, sometimes notched, sometimes drawn out into a canal. The orifice is in general capable of being closed by an *operculum*, a horny or shelly disk, attached to the posterior part of the foot of the animal, and fitting the interior of the mouth of the shell when the animal retreats within the cavity.

The most important difference between the animals of this order consists in the presence or absence of a canal, formed by a lengthening of the lung-chamber of the left side, which is carried along a similar canal in the shell, or through a simple notch, to enable the animal to respire without the need of quitting its shelter. The presence or absence of an operculum is also a distinction; and the filaments, fringes, and other ornaments, which are occasionally carried on the head, the foot, and the mantle, afford other characters for the subdivision of this extensive Order.

FAMILY CYPRÆADÆ.

(*Cowries.*)

Of this extensive group of shells, the majority of which are so exquisitely beautiful that they form the ornaments of cabinets, and the pride of collectors, a single British species is a sufficient warrant for noticing, in this volume, so attractive a family. Most of them are inhabitants of the tropical seas, residing chiefly near the shore, on reefs, and among rolled masses of broken coral; hence archipelagos and smaller groups of islands are peculiarly rich in the lovely Cowry-shells. There the brilliancy and variety of colour displayed both by the shells themselves and by the animals, accord with the glories of those latitudes, where the light and heat of a vertical sun give the greatest stimulus to animal and vegetable life.

The characters of the family are the following: the form is oval, flattened on one side, on which is placed the aperture; this is as long as the shell, narrow, and open at each end: the spire in the adult state is entirely concealed: the outer lip is in general bent inward and thickened. The surface of the shell is often highly polished, with a glassy, or porcelain-like enamel, with no trace of an epidermis, or investing coat of skin.

The animal is large; the mantle is developed into widely-expanded lateral lobes, which are, during activity, turned upward on each side, so as closely to embrace the shell. These lobes are generally gaily coloured, and are often adorned with various fringes and other appendages. The head is furnished with a retractile proboscis, and with a muzzle. The gill-plume is single. The sexes are separate. There is no operculum.

"The difference of aspect," observe Messrs. Forbes and Hanley, "between these mollusks when crawling, with all their beautifully-coloured soft parts exposed, often completely concealing their enamelled shells, and their appearance when, after being seized, they suddenly and instantaneously withdraw their bodies and mantle-lobes, and expose the shell only, is very curious and surprising."*

GENUS *CYPRÆA*.

As specimens of some or other of the numerous species that compose this beautiful genus may be found on almost every mantlepiece, sideboard, and chiffonier, my readers will be at no loss for the means of actual comparison of the following characters by which it is distinguished. The shell is oval, more or less swollen, and flattened on the inferior side: its surface is polished or enamelled, commonly smooth, but sometimes marked with parallel grooves: the aperture is as long as the whole shell, narrow, forming a canal at each extremity; the outer lip is in full age bent inward, and much thickened, and as well as the inner lip, (or that edge of the aperture which faces it,) in almost all the species marked with numerous parallel tooth-like ridges.

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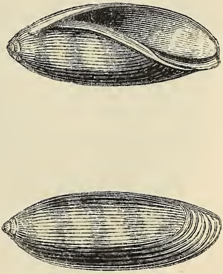
* Brit. Mollusca, iii. 493.

The animal has large smooth, or warted mantle-lobes, capable of entirely embracing the shell between them, their edges meeting along its summit. The head is broad, with a retractile proboscis, and long, pointed tentacles, at the bases of which are the prominences which carry the eyes. The jaws are horny, and there is a long ribbon-like tongue, armed with rows of minute-teeth.

Some species appear to have the faculty of changing the colours with which the mantle is vividly adorned. Mr. Stutchbury, who had an opportunity of examining many individuals of *C. tigris* at the Pearl Islands, has stated that those cowries lived there in very shallow water, and always under rolled masses of madrepore. They never were to be seen exposed to the sun's rays. On lifting one of those masses a tiger-cowry was generally observed with its shell entirely covered by the large mantle, which was mottled with dark colours, the intensity of which the animal seemed to have the power of changing; for the colours varied in the same light and in the same medium, after the manner of the spots on the cephalopodous mollusca, or, to use a more familiar instance, somewhat in the same way that the hues of a turkey-cock's wattle vary.*

Mr. Arthur Adams, however, remarks on this statement: "Although I have examined hundreds of *Cypræa tigris* in a living state, I never saw those changes of colour in the mantle of the animal described by Mr. Stutchbury."†

The form of a cowry-shell is so peculiar, that no one, on first taking it into the hand, would suspect that it is modelled on the same plan as the cones and olives with which it is frequently associated. Yet the structure is essentially the same, and in the youth of the shell the resemblance is manifest, a young cowry being so like an olive as to present no peculiarity worth notice. In the course of growth, however, important changes in the external shape occur, chiefly by the development of the outer lip, and the deposition of the surface-enamel. Mr. Gray defines three stages in the growth of *Cypræa exanthema.* In the first the shell is generally smooth, of a pale greyish colour, or with three transverse bands, and the upper part of the *inner* lip is smooth and convex, the lower part flat or concave; the *outer* lip is thin. The accompanying figures represent this stage.



YOUNG COWRY.

In the next stage the shell begins to assume more of the character of the genus, the outer lip beginning to be bent in, or rather thickened, and the mantle beginning to secrete and to deposit the coat of enamel, which is studded with white spots. The figure displays this state: the spire is sinking behind the elevated lips, which are thickening; while the spotted coat is seen at one side, creeping along over the back of the shell, which it is destined to cover.

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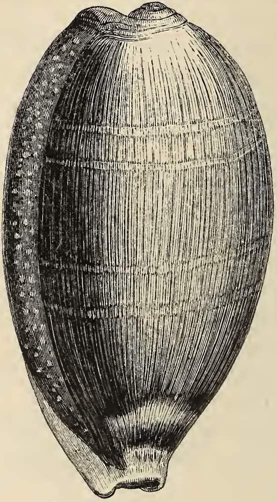
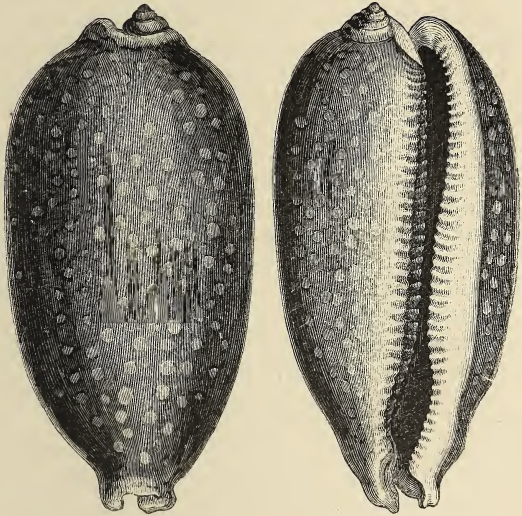
* Zool. Journ. iv. 163.

† Zoology of Samarang, part iii p. 24.


HALF-GROWN COWRY.

At length the thickening of the lips proceeds to such an extent as almost to conceal the spire, and to reduce the aperture to a narrow line, the edges of which are now thickly plaited with the tooth-like ridges so characteristic of the genus. The lobes of the mantle protrude through this aperture, and expanding on each side, have deposited all over the exterior of the shell a coat of glassy enamel, studded with pale round spots, which entirely conceals the transverse bands that were formerly visible across it. The appearance, therefore, is now such as is represented in the following figures, which most of my readers will readily recognise as those of a familiar shell.

The deposition of enamel is the last process of the change, and one to which so much of the beauty of these shells is indebted. It sometimes happens that the glassy coat envelopes, while soft, any accidentally-intruding body adhering to the shell, and, quickly hardening, detains it there. Specimens of cowries are found in collections, on which other shells are fixed, firmly imbedded in the enamel. As such accidents are rare, however, it may be supposed that the frequent use of the mantle-lobes to embrace the shell has a tendency to prevent the adhesion of other shells.



FULL GROWN COWRY.

Some naturalists have supposed that the cowries, precluded, as it appears, (beyond a certain point) from enlarging their shells in the usual manner by the increase of the last whorl, have the power of forsaking their shells, and of forming new ones of larger size, as a crab or lobster sloughs its crust. Others believe that a process of gradual absorption and deposition will meet the necessities of the case, which, however, it must be confessed, presents considerable difficulty.

The earliest stage of life in these animals, as, we believe, in all the *Gasteropoda*, however diverse their adult condition may be, appears under the form of a nautilus-like shell, the inhabitant of which is furnished with two large-winged lobes, by which it is able to swim freely. Mr. Arthur Adams thus describes the young of one of the cowries :—"While staying at Singapore, I had an opportunity, in conjunction with Dr. Trail of that place, of observing the fry of *Cypræa annulus*, the species being then in spawn. Several specimens collected by us at low water, were seen to have conglomerated masses of minute transparent shells, adhering to the mantle and other parts of the animal, which masses, when placed in a watch-glass of salt water, under the microscope, became disintegrated, and detached individuals were perceived quitting the rest, and moving in rapid gyrations, with abrupt jerking movements, by means of two rounded flattened alar membranous expansions, reminding one of the motions of some of the *Pteropods*. When at rest, they joined the principal mass, or adhered, by means of their dilated expansions, to the surface of the watch-glass."*

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* Zool. of Samarang, Part III. p. 23.

According to the same observer, the minute snail-like shell of the young cowry forms the nucleus of that which afterwards grows, and undergoes the changes in form already described. The young are very active, whirling giddily about through the water, and occasionally adhering to foreign bodies, not by any disk for the purpose, but by means of the dilated expansions of the mantle. In the course of growth, these fleshy expansions become entirely absorbed, and do not ultimately constitute the lobes of the mantle which embrace the shell in the adult.

One of the species (*C. moneta*) possesses an interest, as forming a recognised currency in some parts of Africa, and of further India. Their value in Bengal is said to be as follows: 3,500 cowries are equal to one rupee, or about 2*s.* 3*d.* sterling. They are procured chiefly from the Maldives, and the coast of Congo. After the spring-tides, women collect the sea-sand in baskets; the cowries are then picked out, and heaped up in the sun; the animals soon dry up, and the shells, being cleaned, are ready for the money-market.

Many of my readers are doubtless familiar with our little native cowry (*Cypræa Europæa*). It varies in size, from that of a split pea to that of a large horse-bean. It is elegantly marked all over with transverse ridges. These ridges are porcellanous white, and the alternate furrows between are purplish, or flesh colour. The larger specimens commonly display three spots of dark brown,

CYPRÆA EUROPÆA.

arranged lengthwise. But probably few are aware how very elegant a creature it is when tenanted by its living inhabitant, and crawling at ease in clear water. The foot, on which it glides with a slow but smooth motion over the surface of the rock on which it habitually dwells, or, if you please, on the bottom of the saucer of sea-water in which you are examining it, is a broad expansion spreading out to twice the superficies of the base of the shell. Above this is the fleshy mantle, which is so turned up as closely to invest the shell, conforming to its shape, and even fitting into the grooves between the ridges. This mantle can be protruded at the will of the animal, so far that the two sides meet along the top of the shell, and completely cover it; or can be completely retracted within the wrinkled lips beneath; and it is capable of all gradations of extension between these limits. From the front of the shell protrudes the head, armed with two straight and lengthened tentacles, answering in function and appearance to the upper part of horns in a snail; except that the little black points which constitute the visual organs are not in this case placed at the tips, but on a little prominence on the outside of the base of each tentacle. Above and between these, which diverge at a considerable angle, projects the proboscis, a rather thick, fleshy tube, formed by a flat lamina, with its edges bent round so as to meet along the under side. The interior of this proboscis is lined with delicate cilia, by whose constant vibrations a current of water is drawn into the tube, and poured over the surface of the gills for the purpose of respiration. This current may be readily perceived by any one who will take the trouble to watch with a pocket-lens, as I have been this moment doing, a Cowry crawling up the side of a phial filled with sea-water. By placing the vessel between your eye and the light, and fixing your attention on the front of the proboscis, you will presently perceive the minute particles of floating matter (always held in suspension even in clear water) drawn in various directions towards the tube, with a motion which increases in velocity as they approach, and at length rapidly sucked in and disappearing one after another within. It is an interesting sight to see, and one that cannot be looked on without delight and admiration at this beautiful contrivance of divine wisdom, for the incessant breathing of the respiratory organs, in water charged with vivifying oxygen.

Let us now look at the vivid hues of all these organs. The foot, which expands to so great a length and breadth behind the shell, is of a buff, or pale orange-ground colour, delicately striated with longitudinal undulating veins of yellowish white. The mantle which embraces the shell is of a pellucid olive, thickly mottled and spotted with black, and studded with glands protruding through its substance of light yellow; and it is edged with a narrow border of red. The proboscis is vermilion-red, varying in brilliancy in different individuals. The tentacula are of a paler tint, of the same colour, speckled with yellow.

Such, then, is the beauty of the animal which inhabits this familiar and plain little shell; a beauty, of which those who know it only in cabinets can hardly form an idea; while as one gazes on it placidly gliding along, one cannot avoid an emotion of surprise that such an amplitude of organs can be folded within the narrow compass of the shell, and protruded through so contracted an aperture.

FAMILY MURICIDÆ.

(*Whelks*, &c.)

The Rock-shells and the Whelks, with their numerous allies, have commonly been considered as constituting two families, the *Muricidæ* and the *Buccinidæ*, or, to use the terms of Professor De Blainville, the *Siphonostomata* and the *Entomostomata*. But by Messrs. Forbes and Hanley all these mollusca are united in one family, under the name first mentioned; and this appears to be their true relation to each other; for even De Blainville confesses that his two families differ evidently very little, whether in the soft parts or the shell.

The species which, thus united, are very numerous, have the following characters in common: The shell is very variable in form, but always distinctly spiral, often turreted, with an aperture varying in size from excessive width to excessive narrowness, but always provided with a canal, which is sometimes produced into a long gutter, at others is contracted to a mere notch.

The animals are distinguished by a spiral body, with the foot, which is shorter than the shell, rounded in front. The mantle is furnished in front of the breathing-chamber with a long canal, always uncovered, which is used as an organ of prehension. The head is crescent-shaped, with a protrusile, proboscis-like mouth, whence is unfolded a ribbon-shaped tongue, armed with teeth arranged in triple rows, of three in a row. The breathing apparatus consists of two unequal plumes, the leaflets of which are arranged like the teeth of a comb. An operculum is for the most part present, horny in texture, marked with lines which show the layers of progressive growth, but varying much in form, according to the different genera.

Some of the more prominent, or more interesting of the genera composing this important group, I shall slightly notice; and first of all, that fine series of shells which gives name to the family, the genus *Murex*. Many of the species are remarkable for their brilliancy of colouring, and for the beauty and singularity of the forms which they assume. The siphonal canal is sometimes greatly lengthened, as in the species called the Woodcock's-head (*M. haustellum*), and is occasionally beset, as well as other parts of the shell, with long shelly spines, as the Thorny Woodcock (*M. tennispina*): often the progressive stages of growth are marked by beautiful shelly foliations, as in the magnificently-hued Royal Murex (*M. regius*) of South America.

It was from various species of this family, but preeminently from those of the genus *Murex*, that the ancients obtained the purple dye which made Tyre the "crowning city." This rich hue was of great costliness; its beauty has been celebrated by poets and historians, and the very finest kinds were reserved for the hangings of temples, and the robes of kings and priests. In the reign of Augustus, double-dyed purple wool was sold for about 36*l.* sterling per lb. But as wealth would not hesitate at any price to obtain that which was fashionable, laws were enacted, rendering it penal for any one but the emperor to wear cloth of this sort.

The observations of Mr. Wilde have thrown a confirmatory light on the accounts handed down to us by ancient writers of the mode of procuring the dye. This gentleman, when visiting the ruins of Tyre in 1838, found on the shore a number of round holes cut in the solid rock, varying in size from that of an ordinary metal-pot to that of a large boiler. In these cavities, and scattered on the beach around, lay large quantities of shells, broken, apparently, by design, but subsequently agglutinated together. It was evident that the shells had been collected in quantities, and deposited in the cavities in order to be pounded in the very mode described by Pliny, for the purpose of extracting the purple dye contained in the animal. The broken shells proved, on examination, to be all of one species, *Murex trunculus*, which was known to have yielded the Tyrian purple, and recent specimens of the same species were found on the adjacent beach.

In this family are placed the largest of univalve shells, such as the *Tritonium*, of which one species, richly clouded with brown and red like tortoise-shell, is sometimes found two feet in length; and the genus *Cassis*, well known as Helmet-shells, of triangular form and ponderous structure. All these are highly ornamented, especially the massive kinds from the West Indies and the Indian Ocean. The use of the helmets for the cutting of cameos has been noticed in a former page of this volume; but some statistical details on the same subject may not be uninteresting to my readers. They were communicated by Mr. J. E. Gray to the Society of Arts, in 1847.

Mr. Gray observed that numerous attempts have been made to substitute various materials, such as porcelain and glass, for the ancient cameos (which were cut in onyxes and other precious stones); but their great inferiority has caused them to be neglected. The best and now most-used substitutes are shells, several kinds of which afford the necessary difference of colour, and at the same time are soft enough to be worked with ease, and hard enough to resist wear. The shells used are those of the flesh-eating univalves, which are peculiar as being formed of three layers of calcareous matter, the layers being perpendicular laminæ placed side by side.

The cameo-cutter selects those shells which have the three layers composed of different colours, as they afford him the means of relieving his work; but the kinds now employed, and which experience has taught him are best for his purpose, are the Bull's-mouth (*Cassis rufa*) from the Indian seas, the Black Helmet (*C. Madagascariensis*), a West Indian shell, the Horned Helmet (*C. cornuta*), from Madagascar, and the Queen Conch (*Strombus gigas*), a native of the West Indies. The first two are the best shells.

After detailing the peculiarities of these shells, Mr. Gray proceeded to give an account of the progress of the art, which was confined to Italy until within the last twenty years, at which period an Italian commenced the making of cameos in Paris; and now about three hundred persons are employed in this branch of trade in that city. The number of shells used annually, thirty years ago, was about three hundred, the whole of which were sent from England, the value of each shell in Rome being 30*s.* The increase of the trade is shown by the following account of the number of shells used in France in the preceding year:—

80,000	Bull's-mouth, valued at	£6,400
8,000	Black Helmet ,,	1,800
500	Horned Helmet ,,	60
12,000	Queen Conch ,,	700
100,500	shells. Total Value	£8,960

The average value of the large cameos made in Paris is about six francs each, giving a sterling value of £32,000, and the value of the small cameos is about £8,000, giving a total value of the cameos produced in Paris for one year of £40,000, while in England, not more than six persons are employed in this trade.*

Those glories of a conchological cabinet, the Harp-shells (*Harpa*), are also members of the present family. The number of species is but small, and they are all found in the Indian Seas, especially around the Mauritius and neighbouring islands, whence the finest specimens of the common species, as well as of the more valuable Many-ribbed Harp, are procured for the European collectors. The animal is brightly coloured, and beautiful. The fishing for these shells is carried on at low water, with a small rake, to which a net is attached, on sand-banks, at night and at sunrise, when the Harps principally roam about to feed. They have been known to take the bait on the fishing-lines laid for Olive-shells.

" The shells when in fine condition are great favourites with collectors, and indeed a drawer of fine Harps, in all the freshness of their beauty, is a sight worth seeing. Care should be taken to keep them with their mouths downwards, and from the sun and light, or their brilliant colours will soon fade."*

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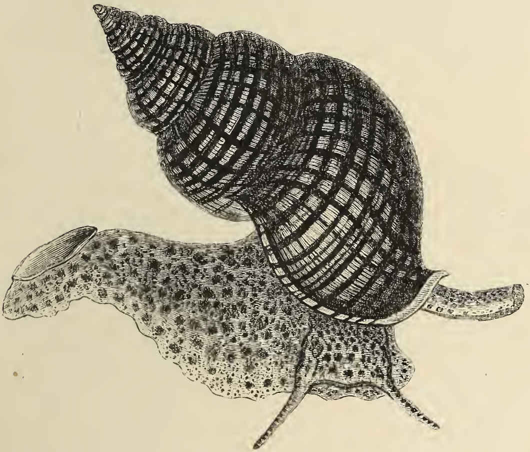
* Athenæum, May 1, 1847.

I must not omit to mention also, the more homely, but at the same time, more useful Spindles and Whelks of our own shores. The former genus (*Fusus*) is remarkable for the size of its members. *F. antiquus*, the largest of British univalves, being frequently found six and occasionally seven inches in length. This shell is used by the inhabitants of the Shetland Isles as a lamp, suspended horizontally by a cord, the ample cavity being made to hold the oil, and the wick projecting from the canal. The



WHELK.

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* Penn. Cyclop.; art. ENTOMOSTOMATA.

Whelk (*Buccinum undatum*), as many of my readers well know, is extensively sold on stalls in the streets of London. Hard, indigestible, and unwholesome as it is, there are multitudes of the poorer classes to whom it is a delicacy; it is simply boiled, and seasoned with vinegar and pepper. With our ancestors it seems to have found a place at tables of more pretension, for Dr. Johnston mentions, that at the enthronization feast of William Warham, Archbishop of Canterbury, in 1504, no fewer than 8,000 Whelks were supplied, at five shillings a thousand. Whelks are caught in creels or pots, baited and sunk in shallow water.

The genus, however, which I select specially to exemplify the family is the following:—

GENUS *PURPURA*.

It was included by Linnæus and his followers under the great genus Buccinum, but has now been separated to include a considerable number of species having the following characters:—

The shell is oval, with the spine usually much shorter than the aperture, which, in most of the species, is very wide; the surface is sculptured spirally, often forming fringed edges, or rows of knobs: the outer lip is rarely thickened, but is commonly notched; the inner lip is ill defined, covered with a glassy enamel; the pillar is broad, flattened, and sometimes hollowed; a short, strongly notched canal is present, and a horny operculum.

The animal has a broad flattened head, with two tentacles, the bases of which are thickened by the union with them of the eye-stalks; a reticulate proboscis, a long tongue, armed with teeth placed three in a row, of which the middle one is three-pointed, and the outer ones hooked. The mantle is produced into a short siphon; the foot is ovate, notched in front and obtuse behind.

Nearly a hundred species of the genus are found in the warmer seas, some of them of large size, and almost all with a very wide-spread aperture and short spire. Our own common Dog-Winkle (*Purpura lapillus*) approaches more nearly the form of *Buccinum*: it is an exceedingly variable shell in size, colour, and sculpture; its most common appearance is white or pale yellow, sometimes banded with light or dark brown, and sometimes wholly of a deep chocolate hue. The figure on page 38 will enable my readers to recognise it, especially as it is one of the most abundant of our native shells, occurring by thousands on every rocky shore.

I have already described in the introductory chapter of this volume, the purple secretion possessed by this mollusk, and the mode of applying it; the dye is common to the genus, and in a greater or less degree to many genera of the same family.

The Dog-Winkle is to be found attached to rocks and stones between tide-marks, and few who behold it sluggishly clinging to its hold, would suppose that it is as ravenous and ferocious a tyrant among its fellow mollusks, as the lion or leopard among the flocks. Yet abundant evidence exists to show that it habitually preys upon other shell-fish, both univalves and bivalves. Mr. Hanley has "seen a Purpura devour a Periwinkle in the course of an afternoon, when placed in the same vessel of sea-water, sucking its prey as it were out of the shell, after placing the orifice of its own body-case against that of its victim."

From Mr. Stevenson's interesting account of the erection of the Bell-Rock Lighthouse, we learn that the valves of the Mussel are no defence against the Dog-Winkle.

"When the workmen," says this gentleman, "first landed upon the Bell-Rock, limpets of a very large size were common, but were soon picked up for bait. As the limpets disappeared, we endeavoured to plant a colony of mussels from beds at the mouth of the river Eden, of a larger size than those which seem to be natural to the rock. These larger mussels were likely to have been useful to the workmen, and might have been especially so to the light-keepers, the future inhabitants of the rock, to whom that delicate fish would have afforded a fresh meal, as well as a better bait than the limpet; but the mussels were soon observed to open and die in great numbers. For some time this was ascribed to the effects of the violent surge of the sea, but the *Buccinum lapillus* [*Purpura*] having greatly increased, it was ascertained that it had proved a successful enemy to the mussel. The *Buccinum* being furnished with a proboscis capable of boring, was observed to perforate a small hole in the shell, and thus to suck out the finer parts of the body of the mussel; the valves of course opened, and the remainder of the fish was washed away by the sea. The perforated hole is generally upon the thinnest part of the shell, and is perfectly circular, of a champhered form, being wider towards the outward side, and so perfectly smooth and regular as to have all the appearance of the most beautiful work of an expert artist. It became a matter extremely desirable to preserve the mussels, and it seemed practicable to extirpate the *Buccinum*. But after we had picked up and destroyed many barrels of them, their extirpation was at length given up as a hopeless task. The mussels were thus abandoned as their prey, and in the course of the third year's operations, so successful had the ravages of the *Buccinum* been, that not a single mussel of a large size was to be found upon the rock, and even the small kind which bred there, are now chiefly confined to the extreme points of the rock, where it would seem their enemy cannot so easily follow them."

The mode in which the *Purpura* actually performs the operation, has been described by Mr. Spence Bate from observation. "The Whelk," he observes, "attacked the Mussel, but it bored where there was no *epidermis*. I pulled it off, and turned the Mussel upside down (the other valve having more *epidermis* upon it), but in a short time I returned, and found that the Whelk had turned over the Mussel, and had resumed its operation at its old bore. This I did twice or thrice, with the same result. Giving up the idea of its boring at any other point, I next thought I should like to see how it managed to devour its prey. For this purpose I divided the muscles of the Mussel, so that the valves parted, so as to enable me to observe the work of gormandizing as it proceeded, but to my surprise, the animal gave up all idea of boring, when there was an easier method of obtaining food, and so passed its proboscis between the valves. I think this shows that the Whelk, when it attacks its prey, seeks out for the part most suitable for its operation, and I believe invariably chooses a point from which the *epidermis* has been removed previously. A section of the bore, taken during the operation, shows that it is convex, and contradicts the received notion of the operation being performed by the action of the ribbon, which being in the centre of the proboscis, would perforce wear the middle of the bore deepest, but this is not the case. The animal makes no movement of a rotatory kind or otherwise, during the operation. It takes about two days to get through the shell, when it eats about two-thirds of a moderate-sized mussel, which seems to satisfy hunger for about three weeks." *

The curious inquirer after the many natural objects which the receding tide reveals, may occasionally see in the spring months as he peeps into the crevices of the rocks, a number of little urn-like bodies crowded together, and standing erect from the rock. They are about the size of a grain of wheat, to which they bear no small resemblance, being of a yellow colour, but tinged as they approach maturity with reddish-purple. These are the egg-capsules of the Dog-Winkle. Réaumur states, that the purple dye is obtained from these vesicles with less trouble than from the animal; an assertion which by no means agrees with my experience. The membrane of which they are composed is very tough, but if we cut it open we find that each contains many infant mollusks, all inclosed, as the period of birth draws nigh, in their tiny shells.

Mr. Peach, who bred the animals from the capsules, observed that the latter change form as the included young ones ripen, the apex of the cup becoming thinner and more convex. He found that so long a time as four months elapsed before the vesicle opened, and then the included whelklings did not quit their cradle all at once, but took their time in coming out, according to their individual dispositions; doubtless, the quick-minded and more curious commencing their travels first, whilst those of slow and studious constitutions would remain as long as a fortnight before resolving to see the world, which with young *Purpuræ* is no very dangerous adventure, since the neighbouring barnacles enable them to look about with safety, before making a long journey from their birthplace.*

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* Forbes and Hanley's Br. Moll. iii. 385.

FAMILY VELUTINIDÆ.

A small and unimportant group is indicated by this name, represented in Britain by two genera, each consisting of two species. They have a shell, the aperture of which is very broad and open, and the spire minute; in texture it is thin, sometimes pellucid, and sometimes even membranaceous. In one genus it is entirely included within the substance of the mantle, as in *Pleurobranchus:* in the other it is external, but partially invested by the edges of the mantle, and covered with a skin (*epidermis*).

The animal is large, with a short broad head, furnished with two tentacles, and eyes at the exterior of their bases. There are two gill-plumes. The operculum is wanting.

Our most common species is *Velutina lævigata*, reckoned by Linnæus among the snails, and long supposed to be a fresh-water mollusk; it is, however, exclusively marine, and generally inhabits deep water. It is an open-mouthed shell, about half an inch in diameter, of a dull reddish hue, covered with a furry epidermis. Messrs. Forbes and Hanley distinguish it from its fellow species by affirming that it is not membranaceous, but this does not agree with my own experience; the specimens that have fallen under my notice having been quite flexible and membranaceous, especially near the margin. Nothing is known of its habits.

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* Cited in Forbes and Hanley, iii. 384.

FAMILY NATICADÆ.

(*Naticks.*)

The shell in this family is globose, with the spire minute and scarcely raised; the surface is generally smooth, and often covered with a porcelain-like polish; the aperture is large and semicircular; the pillar is always thick and solid, and its exposed part, constituting what is technically known as the inner lip, is often very broad.

The animal is large in proportion to the shell, yet capable of being wholly withdrawn into it. The mouth is not extended into a proboscis, but is concealed beneath a broad hood or veil. When the eyes can be recognised, they are placed at the bases of the tentacles. The mantle is entire, that is, its edges are not cut into filaments. An operculum is always present, sometimes horny in texture, sometimes shelly, but invariably closing the wide aperture of the shell.

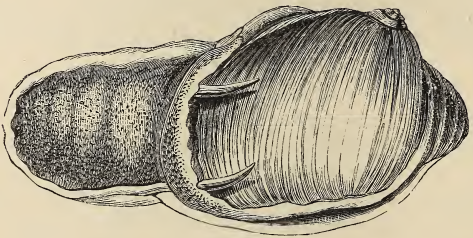
Though the genera comprised in this family are few, the constituent species are numerous, and widely scattered in geographical distribution. For the most part they are marine, but some inhabit rivers and lakes of fresh water; and M. Lesson affirms of one species which is found in Australia, that it lives abundantly on trees. Some of the *Neritinæ* are ascertained, on indubitable authority, to live indifferently in the sea and in fresh-water.

Genus *NATICA*.

Handsome globose shells, with a smooth surface as if varnished, and with a very wide aperture, compose this genus, which is technically distinguished by having the inner lip smooth, not depressed; the umbilicus open, with a central gibbous ridge or prominence, and the operculum formed of shelly substance.

The animal is large, slimy, and slug-like, with the foot so enormously developed as to communicate to the creature a most remarkable aspect when seen crawling. It is a long oval plate of soft flesh, commonly squared in front, and rounded or notched behind. The forepart, where it is widest, forms a thick sort of shield, somewhat eared, which is turned up on the front of the shell, partially covering it, and hiding the whole head of the animal, except the tentacles, which project from behind it. The hind part of the foot, and the sides also, partially envelope the shell, of which only the summit is seen, apparently embedded in an immense mass of white flesh. The operculum, notwithstanding its large size, is not visible when the animal is in motion, being hidden by the extremity of the shell.

When one beholds the great volume of fleshy substance which the animal displays when crawling, we can scarcely believe that it can possibly be withdrawn into the shell; yet this is easily effected, and that so completely, that the closely-fitting operculum is seen, shutting the aperture considerably within the margin. It is performed, however, if I may judge from my own experience of several British species, with some difficulty, and by a succession of efforts; and the animal when once forced by annoyance to retire, is often ill-disposed to protrude again, at least for a considerable time.



NATICA.

The species of the genus are widely distributed, and are most numerous within the tropics. Several of them are of large size. Seven or eight species are found on the British shores, of which the finest is *Natica monilifera.*

In this large and handsome shell, the form is globose, nearly as broad as long; it is strong but not solid, smooth and glossy, though with a few fine sunken lines, which mark the progressive growth. The ground-colour is whitish, sometimes tinged with flesh-red, or with bay, and each whorl is marked along its upper margin with a line of oblique but parallel dashes of rich chestnut.

The animal, in such specimens as I have seen, is almost wholly of a pure milk-white hue. It is, as already stated, very large, the long oval foot extending far beyond the outline of the shell on every side, and partly inclosing it. Messrs. Forbes and Hanley state that this is a local species, found, however, on most parts of our coast where sand is plentiful. I have taken it by dredging in Weymouth Bay, where it seems a common species, together with *N. Alderi.* Both of these animals have a curious habit, which I have not seen noticed. They are said to live *buried in sand*, but I believe this is only to a partial extent. When put into an aquarium with a sandy bottom, they soon begin to crawl just beneath the surface of the sand, the foot alone being immersed in it; and this organ as it slowly moves along, deposits and leaves behind a broad belt of clear mucus, of slight density. The progress of the creature through the fine soft sand, is very curious to witness.

In places where this *Natica* is common, the dredge not unfrequently brings up its spawn-masses. Professor Harvey in his delightful "Sea-Side Book," thus speaks of them.— "These egg-clusters are really very curious and elegantly formed objects, which must often have attracted the notice of a rambler, who felt puzzled to know what they were. They are firmly gelatinous, or of the consistence of gristle, transparent, or nearly so, slightly coated with fine sand, and in shape resemble the hoof of an animal. When dry, they look not unlike pieces of thin Scotch oaten bread. The surface is marked with little hexagonal spaces, which define the eggs. But what is most to be admired in the structure, is the form of the curves which the hoof-like body assumes, which fit it for lying on loose sand, without becoming deeply buried in it."* I am inclined to believe that the original form of this egg-mass is that of a very broad ribbon, attached by one edge to a rock, like that of a *Doris*, in a spiral curve, the upper edge of the ribbon leaning outwards a little, so as to resemble a cup, and that the likeness to a horse-hoof which Professor Harvey alludes to, and which I have myself observed, is seen only when the ribbon is torn away by the dredge, and turned upside-down. This curious mass of eggs was considered to be a zoophyte by the earlier naturalists, and was characterised as such by Gmelin, under the name of *Flustra arenosa.* Its true nature was first suspected by Mr. Boys, and was fully proved by Mr. Hogg, in 1833, who hatched the *Natica* from it.†

The species of this genus are all carnivorous, boring holes into other shells and devouring their contents. Dr. Gould asserts that they are very voracious, and play a conspicuous part in devouring the dead fish and other animals which are thrown up by the tide. The small circular holes with which bivalve shells are often drilled, are the work of these snails, and made by them to gain an entrance to the animal apparently so well secured against such a foe. The foot can be expanded so as to envelope completely the objects on which they prey, for a long retention of it in its grasp is necessary, from the slowness with which they work their auger or spiniferous tongue.‡

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* Sea-Side Book, p. 33.

† Linn. Trans. 1833.

‡ Invertebr. of Massachusetts, 232.

FAMILY PYRAMIDELLADÆ.

This is an extensive group of small, and for the most part, minute shells, which often display much beauty to the close observer; their forms being in general elegantly turreted, their surfaces smooth, often polished, or ornamented with the most beautiful and elaborate sculpture. The aperture is entire, and not lengthened into a canal; the pillar or inner lip is often plaited.

The animals are furnished with a retractile proboscis, and with tentacles of varying form, with the eyes not set on footstalks, but immersed in the bases. The tongue is remarkable for being unarmed with teeth.

As the fossil remains of a former world present the extinct forms of this family in great numbers and variety, the group is one of much interest to the geologist.

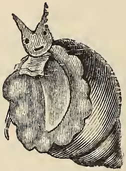
GENUS *STYLIFER*.

I select the genus *Stylifer* to illustrate the family, because of its singular form and still more curious economy, rather than for its abundance in these latitudes, for it is represented on the British coast by a single species, and that of very rare occurrence.

The shell is somewhat globose, with the tip slender, and projecting in the form of a little point or style; its surface is smooth and polished; its whorls are numerous. There is no operculum.

The animal has slender tentacles, and eyes immersed at their bases; the mantle has been described as thick, fleshy, cup-shaped, enveloping the last whorl of the shell, but Mr. Adams from observation on the living animal, informs us that it is entirely enclosed and covered by the thin shell, while the foot is narrow, slender, and very much produced beyond the head in front.

The habits of this interesting mollusk are most singular, for it is found to live parasitically upon the animals of the class *Echinodermata* (Star-fishes and Sea-Urchins). Three species are known, one of which (*Stylifer Turtoni*) is a rare inhabitant of the British seas. Dr. Turton, however, its discoverer, found no fewer than a dozen attached to the spines of *Echinus sphæra*, dredged in Torbay. It has since been found in several localities, as on the coasts of Northumberland, Durham, and Cork, always under similar circumstances. Mr. Alder states, that it occurs on young Sea-Urchins.



STYLIFER.

A fine species was discovered in the Indian Archipelago by Mr. Hugh Cuming, and named *S. astericola.* He found this elegant parasite burrowing in different parts of the oral disc of *Asterias solaris.* It was almost hidden from sight, so deeply does the animal penetrate into the substance of the star-fish, in which it makes itself a comfortable *cyst* (or cell) for itself, and wherein it most probably turns by aid of its rudimentary foot. All the specimens infested with these testaceous mollusks appeared to be in the best health, though there is reason to believe that they feed upon the juices of the Star-fish. Mr. Broderip observes that *Stylifer* (with that instinct of self-preservation which is imparted to all parasites whose existence depends upon that of their nidus) appears, like the larvæ of the ichneumon tribes among insects, to avoid the vital parts; for in no instance did Mr. Cuming find it imbedded anywhere save in the rays, though some of the individuals had penetrated at their base, and very near the disc. When extracted, the older shells have the appearance of a milky-clouded glass bubble: the younger shells Mr. Broderip found of an unclouded transparency.

FAMILY SCALARIADÆ.

(*Wentletraps.*)

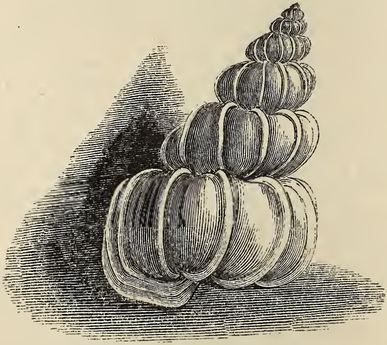
Though very limited in numbers, this family is interesting to the conchologist as containing some species of singular form and remarkable beauty, one of which was formerly valued so highly as to command enormous prices, and to have acquired the name of the Precious Wentletrap. "In this family a spiral shell with an entire aperture is combined with an animal whose head is not produced into a muzzle, but furnished with a retractile trunk. The sexes are distinctly separated. The eyes are immersed at the external bases of subulate (*awl-shaped*) tentacles." The dentition of the ribbon-like tongue is very peculiar; there is no central tooth differing from the rest, but all are alike, arranged in transverse rows, and forming simple claw-like hooks. The animals are probably predaceous like the Whelks, &c. Most of the species, which amount to nearly a hundred, inhabit the seas of warm climates, though a few are found on our own shores.

GENUS *SCALARIA*.

The shell is spiral, consisting of many whorls, assuming a turreted form, ornamented with many elevated ribs, which cross the whorls in the same direction as the length of the shell; the aperture is rounded, with the lip thickened and entire. There is a horny operculum.

The animal has an angularly lunate head, with two long pointed tentacles, and eyes immersed at their bases; the mouth, which opens below, has a retractile proboscis; the mantle is rudimentary; the foot is triangular, grooved beneath, and furnished in front with a fold.

In the principal section of the genus, confined to the warmer parts of the globe, the whorls or turns of the spire do not touch each other in any direction: these are designated *true* Wentletraps. In this division is placed the shell above alluded to,

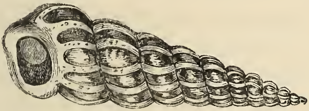


PRECIOUS WENTLETRAP.

the Precious Wentletrap or Royal Staircase (*Scalaria pretiosa*), a large shell, twisted into a loose, untouching spiral, of a pale yellow hue, ornamented with ribs of pure white. This is always a prized addition to a cabinet, for it is undoubtedly a shell of extraordinary beauty; but the value which was attached to it in former years can only be considered as a phase of insanity, analogous to the well-known *tulip mania*, and other fantasies of a like kind. In 1753, at the sale of Commodore Lisle's shells at Longford's, four Wentletraps were sold for seventy-five pounds twelve shillings: viz. one not quite perfect, for sixteen guineas; a very fine and perfect one for eighteen guineas; one for sixteen guineas; and one for twenty-three pounds two shillings.*

But higher prices than these have been given. That in Mr. Bullock's museum, supposed to be the largest known, brought at his sale the sum of 27*l*., and was estimated in 1815 at double that value; and there is a tradition that a specimen was sold in France for 2,400 livres, or 100 louis!

Another section, known as *false* Wentletraps, have the whorls contiguous; and many of these species are European. Some of them secrete a purple liquor, as has already been noticed in these pages respecting our commonest native species, *S. communis.* This shell is turreted, usually about



COMMON WENTLETRAP.

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* Da Costa's Elements, 204.

an inch and a quarter in length, of a pale bay or drab hue, with prominent ribs, spotted with purple. The animal is blackish-grey speckled with white.

The Wentletraps inhabit rather deep water, and affect a sandy or muddy bottom: hence they are obtained only by dredging. The species just described has been procured at various parts of our coast, but principally on the shores of Devonshire.

FAMILY CERITHIADÆ.

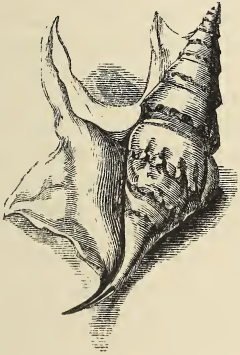
This group, as defined by our latest malacologists, includes shells which at first sight appear to be very dissimilar, as the slender turreted *Cerithium* and the broad-lipped Pelican's foot. The genera are " remarkable for the muzzle-shaped heads and corresponding features of organization of the animals which construct them." They seem to constitute a group intermediate between those comb-gilled *Gasteropoda* which have entire mouths, and those which are furnished with siphons, partaking of and mingling many of the characters of both.

GENUS *APORRHAIS.*

A thick, massive, many-whorled shell marks this genus, subject to much alteration in form as it advances in age. In youth the aperture is simple, slightly angular, with a moderate canal; in adult age the canal becomes lengthened, and the outer margin of the shell is produced into a wide wing-like expansion, the edge of which projects in diverging lobes or finger-like processes.

The animal has a long muzzle; cylindrical tentacles, with the eyes placed on prominences at their bases; the mantle digitated, loose, with a rudimentary siphon; the foot short, angular in front, and obtuse behind; the branchial plume single; the operculum horny.

We have two native species, called the Cormorant's foot (*A. pes carbonis*), and the Pelican's foot (*A. pes pelicani*). Of these the former is exceedingly rare, the latter very common. The name in both cases is derived from the wing-like expansion of the adult shell resembling the webbed foot of a sea-bird. The Pelican's foot is the larger shell, measuring commonly about two inches in length, and nearly an inch and a half in width, when full grown. Its colour is yellowish, with clouds and spots of chestnut brown. The animal is yellowish-white, marked with scarlet spots, especially about the head and on the tentacles. It is commonly brought up by the dredge, particularly from a gravelly bottom. In captivity it is uninteresting, as it remains sluggish and inactive, obstinately



PELICAN'S FOOT.

keeping its body contracted within the shell. Though I have kept many specimens, I have never seen one crawl.

Family Turbinidæ.

(*Winkles.*)

An immense assemblage of species, some of which are of large size and great beauty, is comprised in this family. The animal is spiral, with the sides occasionally ornamented with tentacular appendages differing in number and form; the head is protruded somewhat in the form of a proboscis, furnished with slender thread-like tentacles; the latter carry at their bases a pair of eyes, usually raised on footstalks; the mouth has no tooth on the lip, but is provided with a ribbon-shaped tongue of great length, rolled up spirally when not in use, and carried in the cavity of the body. A furrow passes across the foot near its front border; the gills consist of two fringes.

The shell is thick and solid, often more or less pearly on the inside, forming a spiral cone, with the opening round or slightly depressed. There is an operculum, which is calcareous (shelly) in some species, horny in others; in the latter the spiral formation is visible on the outside, in the former on the inside.

All the members of this family are believed to be vegetable feeders, subsisting on the sea-weeds, the substance of which they rasp down by the action of their rough tongue. Yet the large and beautiful *Phasianella bulimoides*, an Australian species assigned to this family, is said by MM. Quoy and Gaimard to be taken in nets baited with flesh, and let down into the sea.

GENUS *LITTORINA*.

The shell in this common and well-known genus is spiral with but few whorls, generally more or less oval in form, and thick and solid in substance. The spire is sometimes pointed, as in the common Periwinkle (*L. littorea*); sometimes obtuse or round, as in the equally common Yellow Winkle (*L. neritoides*). The aperture is round and entire; the outer lip is sharp-edged, thickened within. The operculum is horny and elastic; its spire consists of a few turns, rapidly enlarging, with a central nucleus.

In most of our seaport towns, and in many of our inland cities, the Periwinkle is sufficiently familiar, from its being so commonly sold by measure as human food. The animals are found by thousands on rocks at low-water, or on the mud left exposed by the receding tide in harbours and estuaries; they are collected by the children of fishermen, boiled, and hawked about the streets at a low price. They are eaten not infrequently by persons above the lowest grade of society, not from necessity, but from choice; though to most uneducated palates they are coarse, tough, and indigestible.

The Periwinkles are able to bear long-continued exposure to the air with impunity. The species just mentioned may be observed adhering to the rocks by hundreds under a hot sun, and that for hours together; but a smaller kind (*L. rudis*),—which may be recognised by its being frequently found white, pale-green, yellow, and orange in colour,—habitually resides in hollows of rocks that are elevated many feet above the range of high-water. But their gills are constantly moistened by a minute quantity of sea-water contained in the cavity of the body; and this is prevented from evaporation, partly by the close adhesion of the margin of the shell to the rock, and partly by the tightly-fitting operculum.

Indeed there is reason to believe that this and some other species of the genus spend the winter in the air, hybernating, like the Snails. "Mr. Gray found that many individuals of *L. petræa*, and some of *L. rudis*, were in this condition, during his stay at Dawlish. They were attached to the rocks several feet above the reach of the highest autumnal tides; the foot was entirely retracted; and a membranous film was spread between the rock and the edges of the outer lip of the shell; the gills were only moist, the branchial sac being destitute of that considerable quantity of water which exists in it in those of the same species which are adherent to it by their expanded foot. In this torpid condition the individuals observed by Mr. Gray continued during the whole of his stay, which lasted for more than a week. On removing several of them, and placing them in sea-water, they recovered in a few minutes their full activity."*

In Sweden the common people affect to prognosticate the weather by the position of the Periwinkles; when these ascend the rocks, it is considered as a sure sign that a storm is near, as their instinct leads them to place themselves out of the reach of the dashing of the waves; on the contrary, when they descend upon the sands it is supposed to indicate calm weather. I much doubt, however, *the fact* of any such connexion between the habits of the Winkle and the state of the atmosphere, and still more, the philosophy of the reason assigned for the habit.

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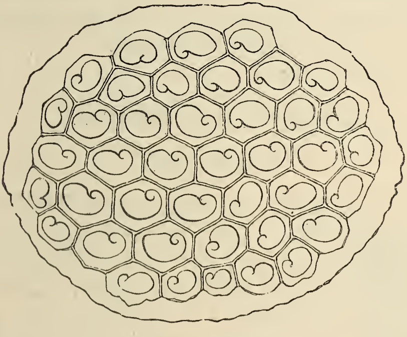
* Proc. Zool. Soc. iii. 116.

The plant-eating *Gasteropoda* are said to "lay their eggs merely enveloped in a mass of jelly, just firm enough to retain its form in the water, and which, deposited on the fronds of sea-weed, or on the surface of rocks and stones, adheres to them with tenacity. The form of the mass is roundish, oval, or oblong, and it may be more complex in some. The ova are always immersed in the mass, which forms a common bed to the whole; but besides this, each egg (or at most three or four eggs) has its own proper globule of jelly, contained within a skin or pellicle of the greatest tenuity, and which isolates it from the rest."*



SPAWN OF PERIWINKLE,
(*magnified*).

The accompanying figure, which is copied from Dr. Johnston, represents the mass of spawn laid by the common Periwinkle, in which each of the infant animals is seen enclosed in its proper globule, and covered already with a shell of a single whorl.

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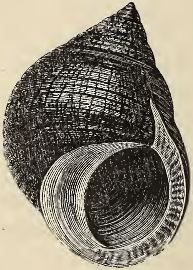
* Johnston's Introd. to Conch. 351.



PERIWINKLE.

The Periwinkle (*L. littorea*) is subject to much variation in form, colour, and markings; it is generally about an inch in height, globose, very thick, with the margin thin; the colour is russet brown, or olive, sometimes yellowish, with spiral bands of black. The ground colour occasionally becomes a rich orange or scarlet, with or without black bands; and these varieties are very handsome.

FAMILY PALUDINADÆ.

(*Marsh Snails.*)

This is a group of fresh-water Mollusks, so closely resembling the Periwinkles in many of their characters as to have been confounded with them by Cuvier and other zoologists. Those characters are as follows:—

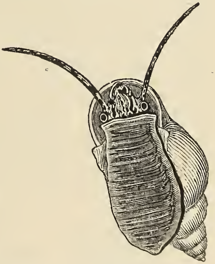
The shell is conical, spiral, thin in texture, covered with an olive-coloured skin; the orifice is ovate, entire, but angular behind. The animal has a muzzle-shaped head, and long, slender tentacles, with eyes seated at the outer side of their bases; the gills are always enclosed in the breathing cavity. An operculum is always present, generally horny, but sometimes shelly, formed of concentric laminæ ranged round a nucleus commonly placed in or near the centre.

Unlike the great majority of the Comb-gilled Mollusca, the members of this family are confined to fresh waters, inhabiting lakes, streams, and marshes. They are distributed all over the world; and occur in a fossil state as far back as the oolitic series. The fine globose shells which are found in the rivers of tropical countries, known as Apple-snails (*Ampullaria*), are but slightly separated from this family.

GENUS *BITHINIA.*

In addition to the family characters, those which distinguish this small group are, that the operculum has a thick shelly coat on the inner surface, and has the nucleus nearly central; and that the aperture of the shell has a slightly thickened rib, along the interior of the margin.

Two species of this genus are found in the streams and ditches of this country, the more common of which is the Tentacled Bithinia (*Bithinia tentaculata*). It is about half an inch in length; the shell is often covered with a blackish foul coat; the spire is composed of five whorls, the lowest of which is swollen. The animal is purplish black, with brilliant yellow specks.



BITHINIA TENTACULATA, (*magnified*).

This genus, like the Mollusca generally, produces eggs, while its fellow-genus *Paludina* is viviparous. The mode in which the eggs are laid is curious, and has been particularly described by M. Bouchard Chantreaux. According to this careful observer, the Tentacled Bithinia lays from May to August.

FAMILY NERITIDÆ.

(*Nerits.*)

A single British species represents a family which, in warmer climates, plays a conspicuous part along the shores of the ocean, and in their rivers and lakes. The members have solid shells, more or less oval, the last whorl so greatly developed as to occupy by far the principal portion, the aperture very open, somewhat crescent-shaped, with an expanded and flattened inner lip.

The animals have broad muzzle-shaped heads, with awl-shaped tentacles, and eyes on short footstalks; the foot is somewhat three-sided, without any lateral filaments. An operculum is always found, which is spiral, semi-oval, and furnished with two internal processes on its front edge, forming a sort of hinge on the sharp edge of the inner lip of the shell. Dr. J. E. Gray thinks that this peculiar structure of the operculum "makes this family more closely resemble the bivalve shells: the processes appearing to answer the same purpose (that of keeping the two parts in their proper situation) as the teeth of the hinges in the bivalves."

GENUS *NERITINA.*

The shell in this genus is semi-oval, without any perforation; the inner lip is slightly toothed, sharp-edged; the surface is smooth, or striated, or spinous, covered with a skin.

The animal has two slender tentacles; a rather short foot, three-sided in outline, with the angles rounded. The tongue is armed with rows of teeth, differing much in form and size. The operculum is semi-oval, slightly shelly, with a sharp, flexible outer edge, and a tooth on its lower margin.

Many species are assigned to this genus, the greater number of which inhabit fresh-water rivers, especially of tropical countries, where they adhere to stones with considerable tenacity. Yet there is a species which inhabits one of the great North American rivers, through a range of two hundred miles, from the mouth, where the water is quite salt, to beyond the reach of the tide, where it is perfectly fresh. Another species is found only in the sea.

When the animals have arrived at their full size, they have the power of absorbing the shelly matter of the divisions which separate the whorls of the spire, so as to allow more room for the spiral body, without increasing the size of the shell. This reduction of substance is accomplished without endangering the strength of the shell, as only a very small part of the whorl is exposed on the outside.

Our single native species (*Neritina fluviatilis*) is about three-eighths of an inch long, and two-eighths broad; usually of a purplish hue, banded or chequered with spots of white; but the colouring of different specimens varies exceedingly. The animal is white, with the head and neck black. It is found chiefly in slow-running streams, adhering to stones. The shells are

NERITINA FLUVIATILIS.

often covered and disguised by irregular incrustations of calcareous matter, deposited by the water, which may serve as a protection to the animals, causing them to take the appearance of rough stones or masses of earth. This species, like all its fellows, displays very little of its body when crawling.

FAMILY TROCHIDÆ.

(*Top-shells.*)

An extensive group of very fine shells is included under the above appellation, many of which are of considerable size, of very regular and elegant shape, and of exquisite beauty of colour, and sometimes of sculpture. Our own shores possess many species, among which are some of the finest of our univalve shells, and specimens distinguished by all of these characteristics. Yet the finest species are, as usual, exotic, and tropical; for the great Pearly Top (*Trochus pica*) of the West Indies, the Imperial Sun (*Imperator imperialis*) of Australia, and the Perspective Staircase (*Solarium perspectivum*) of the Indian Seas, belong to this family.

The shell in this large group varies considerably in form, but is always spiral; the spire sometimes is drawn out to great length, at other times so much depressed as to be nearly flat; but it always forms a large portion of the shell. The aperture is entire, without notch or canal, as the animals are destitute of a siphon.

The animal has a head terminating in a broad muzzle, and often ornamented with head-lobes; side-lobes greatly developed, and furnished with lappets and tentacular filaments, a pair of true tentacles, and eyes fixed on footstalks behind their bases; the gill-plume is single; and an operculum is always present, spiral in structure, commonly circular in shape, and either horny or shelly in texture.

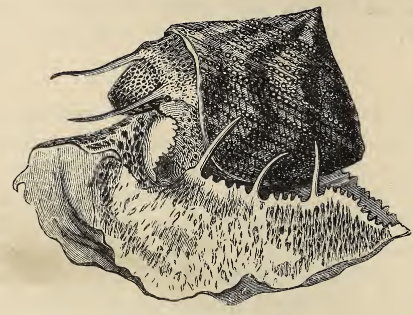
Genus *Trochus.*

Even a glance at the British species of this genus would show the great diversity that subsists in the external form of the shell, from the regular pointed cone, in which the whorls do not break the uniformity of the outline, as in the beautiful *T. granulatus* and *T. striatus*, &c., to the tubercled, almost hemispheric form of *T. magus*, in which the swollen and knobbed whorls project like a winding staircase round a pictorial "Tower of Babel."

The aperture is entire, usually angular, and approaching to a four-sided figure, and opens on a plane which is oblique with respect to the axis of the spire. The interior of the shell is pearly.

The animal is considerably developed; it is furnished with a pair of tapering tentacles, and two eyes set at the ends of stout footstalks. Behind these, on each side, is a large lappet, which merges into a broad wing-like expansion of the mantle, bearing commonly three, sometimes more, tentacular filaments, which are probably delicate organs of touch. The foot is oblong, more or less lengthened, carrying on its posterior part an operculum, which is composed of many spires, of horny texture.

Of the sixteen species which are enumerated as inhabitants of the British seas, one of the most beautiful, and certainly the largest, is the Granulated Top (*Trochus granulatus*). It is esteemed a local and rather rare shell, being confined to our southern shores and the Irish Sea. I find it quite common in Weymouth Bay, in from eight to twenty fathoms. It not unusually attains a height and a breadth of an inch and a quarter, and has been taken of an inch and a half. Its shape is elegantly conical, with the base rounded; the whorls scarcely break the regularity of the outline; they are sculptured with spiral raised lines, each of which is composed of a number of minute rounded knobs, like a string of beads. The texture of the shell is thin and rather fragile; its ordinary tint is a pale flesh-colour, or yellowish white, with a few scattered dashes or short streaks of purple, that run parallel with the spiral lines.



GRANULATED TROCHUS.

The animal is large and handsome, with the lobes and wing-like appendages much developed. It is white, speckled with brown, especially about the head.

All the species of the genus feed on marine vegetables: I have watched with pleasure the little Grey Top (*T. cinerarius*), the commonest species of our weed-clad rocks, rasping down with the teeth of its ribbon-like tongue the minute *Confervæ* that grow on the inside of my glass vases. With a pocket lens it is easy to see the process, which I can compare to nothing else than the mode in which a cow *licks up*, as it were, the grass, as she moves along, by successive sweeps of her tongue.

FAMILY FISSURELLADÆ.

(*Keyhole-shells.*)

In external form and appearance, the shells which compose this group bear the closest resemblance to the Limpets (*Patelladæ*). All of them, however, have the peculiarity of an orifice in the shell, either at the summit of the cone, or in the form of a slit at the front edge.

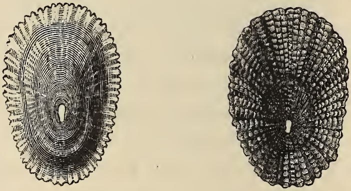
The characters of the included animals distinguish them at once; they have well-developed heads, with short muzzles, and tapering tentacles, at the outer bases of which the eyes stand on short footstalks. Beneath the mantle on each side is a series of short tentacular filaments, similar in character to those of the *Trochidæ*. There are two gill-plumes, which are large, pectinated, and equal; they are placed in an ample cavity, which communicates with the aperture of the shell, whether this be situated on the summit, or in the front margin.

All the mollusks of this family are marine, and are distributed through the seas of most parts of the world; but principally those of warm climates.

GENUS *FISSURELLA.*

From the usual form of the orifice in the shell of this genus, which resembles that of a key-hole, the species are familiarly known by the appellation of Keyhole Limpets. It is placed at the summit of the shell, which is very regularly conical, and not otherwise to be distinguished from that of a *Patella.* In the very young condition the orifice is placed more forward. The animal has been already sufficiently described.

We have but a single native species, the Netted Keyhole Limpet (*Fissurella reticulata*). It attains an inch in length, is of an oval form, and of a dirty white hue, with dusky rays. Its surface is sculptured with a raised network, formed by radiating and circular ridges. The animal is large, and of a yellow colour, varying in shade from cream-white to a rich deep orange; the latter hue being seen only in those specimens that are found adhering to shells incrusted with a scarlet sponge. It is obtained only on our western and southern coasts.



FISSURELLA RETICULATA.

FAMILY CALYPTRÆADÆ.

Another group of Limpet-like shells are associated under this title, represented poorly in the British seas, but numerous and much varied in their details in those of the tropics. They are commonly more or less circular in outline, rising into a cone, the tip of which sometimes is produced into a spire, which falls over. In the interior of the shell, there is in some of the genera a variously shaped shelly plate, which is quite wanting in others.

The animal has a distinct head furnished with tentacles, and eyes placed at their bases; the muzzle is not produced into a proboscis. The tongue is armed with teeth, arranged in rows of seven each, the central one differing in form from the others. The gill plume is single, and the foot is unfurnished with lateral filaments.

Some of the genera, at least, sit on and hatch their eggs. According to Audouin and Milne Edwards, the parent *Calyptræa* " disposes them under her belly, and preserves them as it were imprisoned, between the foot and the foreign body to which she adheres, her patelloid shell thus serving not only to cover and protect herself, but as a shield to her offspring. These eggs are oval bodies of a yellow colour, enclosed in membranous capsules, which are elliptical, flattened, translucid, and filled with an albuminous matter. The number of these little capsules varies from six to ten; they are connected among themselves by a footstalk, so as to represent a sort of rosette; each of them contains from eight to ten eggs. It appears that the young *Calyptrææ* are developed under this sort of maternal roof, and do not quit it until they are in a condition to affix themselves, and are provided with a shell sufficiently hard to protect their own bodies." *

Our other native genus of this family is said to manifest an instinct similar to this.

GENUS *PILEOPSIS.*

The Fools-cap Limpets, as the mollusks of this genus are called, have the shell shaped like a somewhat high cone, with the summit a little produced, and turned over backwards. The surface is commonly marked with lines (*striæ*), and covered with a horny skin, which is sometimes invested with a short velvety down. The interior has no plate or partition of any kind. The place of the attachment of the muscle is marked by a horseshoe impression. The animal has been already described.

The only British species is commonly known by the appellation of Torbay Bonnet (*Pileopsis Hungaricus*); it also bears the names of Fools-cap Limpet, Cap of Liberty, and Hungarian Bonnet, all of which designations, as well as both of its scientific ones, have an obvious reference to its form. It is a rather large shell, being frequently more than an inch and a half in diameter, and an inch in height. Its substance is rather thin, though strong, and somewhat translucent; its colour is a delicate pink, or flesh-white, though this is concealed, especially around the lower part, by an olive-coloured skin, covered with shaggy down.

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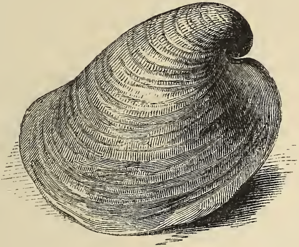
* Litt. de la France, i. 133.

The interior of the shell is delicately smooth, and of the same roseate hue as the exterior.

The animal is usually pale yellow, with a pink mantle bordered with a fine orange-coloured fringe. The head, which is large and swollen, is tinged with brown.



TORBAY BONNET.

Though generally distributed, the Fools-cap must be considered a rare shell. Torbay, as one of its familiar names indicates, is the locality in which it occurs in greatest abundance. I have had several specimens brought to me from Weymouth Bay, and the West Bay of Portland. Messrs. Forbes and Hanley state that it "chiefly inhabits rocky ground, and oyster and scallop banks, adhering to shells living in various depths of water, from fifteen to as deep as eighty fathoms, and extending its range to considerable distances from land. It is finest in from fifteen to twenty-five fathoms, and usually small in very deep water." *

It has been proved, says M. Deshayes,† by observation, that the animals of this genus are

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* Br. Moll. ii. 461.

† Annales du Muséum.

still more sedentary than the true Limpets, for there may be seen in certain individuals of the *P. Hungaricus* irregularities, proceeding from the body on which it has lived when young, continuing exactly the same to adult age; irregularities whose traces may be observed on the lines of growth, and which prove, in the opinion of M. Deshayes, that during its whole life the animal has never changed its place. But, probably, M. Deshayes was not aware of those interesting facts which have been observed in the habits of the true Limpets, already described in these pages; for, if a similar habit of roaming for food, and returning with precision to the exact spot which it has chosen as its home, be common to the Foolscaps also, it appears to me that the phenomena alluded to by the eminent French zoologist would be sufficiently accounted for without his hypothesis.

FAMILY DENTALIADÆ.

(*Tusk-shells.*)

On many a pebbly beach upon our coasts there is frequently found, among other shells washed up by the sea, one which bears the closest resemblance to an elephant's tusk in miniature. It is the representative of a family, comprising but a single genus, which is interesting because its characters, as well those of the shell as of the animal, manifest a decided approach to those of another great division of organized beings, the ARTICULATA. Indeed it was formerly considered by the best zoologists to be a genus of *Annelida*, allied to those which form the shelly tubes so commonly seen on submerged shells and stones, known as the family *Serpuladæ;* and this position was assigned to the tusk-shells by Cuvier, even in his last edition of the "*Règne Animal.*"

The shell, in this family, is a tube more or less curved, wider at one extremity than at the other, and open at both ends. It is, in fact, a very lengthened cone, with an open apex, as in *Fissurella*, a genus with which it has been considered to have some alliance.

The animal is of the same form as the shell, and presents not only in this respect, but also in many details of its structure, peculiarities which distinguish it from all the rest of the *Gasteropoda.* According to Mr. Clark, of Exmouth, to whose elaborate and skilful dissections our knowledge of the anatomy of the Mollusca is so much indebted, the gills are two symmetrical organs, hanging from the sides of the animal, a little behind its middle. The heart is placed at the front of the gill-cavity; a peculiarity of position which is dependent on the curious fact that the water to be respired flows into the gills from the posterior aperture of the shell. The front orifice is occupied and stopped by the thick collar of the mantle, through the centre of which the tip of the foot protrudes. The mantle invests the body like a tube; but if this be slit down the back, a minute head is discovered near the middle of the body, furnished with horny jaws, and bearing on each side a large tuft of filaments, which are considered to be salivary glands. There are neither eyes nor tentacles.

DENTALIUM,
(*natural size,*)
without the shell.

The animal is attached to its shell only at its posterior end; the fore parts are capable of being protruded or withdrawn at the pleasure of the animal. When fully expanded the foot is thrust out in the form of a thickened and pointed tongue, surrounded by a trumpet-like lobe; the whole of which has been compared to the expanded corolla of a flower, with a very thick and pointed pistil.

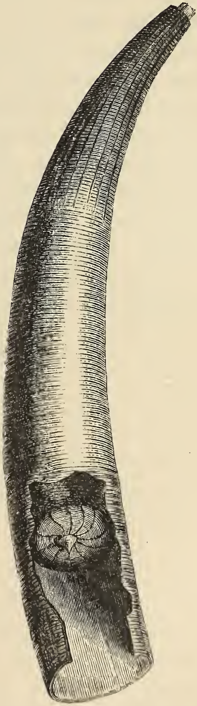
GENUS *DENTALIUM.*

As the family includes but this one genus, it is needless to repeat the characters by which it is distinguished. The species are rather numerous; M. Deshayes enumerates twenty-three living and thirty-four fossil, and several have been added to both lists since he wrote. Their geographical distribution is extensive, few seas being without some representatives of the genus; and they range from deep water to within tide-marks. In their habits they are carnivorous, feeding on those minute animals with chambered shells called *Foraminifera,* as well as on small bivalves. Mr. Clark has found species of as many as eleven distinct genera in the pouches on the two sides of the mouth, or in the stomach, of our commonest Tusk-shell (*Dentalium Tarentinum*). The same acute naturalist has the following observations on the affinities of the genus, already slightly alluded to:—

"The symmetrical, subventral position of the branchiæ, the posterior flow of water to them, and the resemblance of the foot to that of some of the bivalves, combined with the similar character of its action, appear in a striking manner to show its connexion with the *Conchifera:* whilst by its œsophageal cerebral ganglions, and completeness of the circulation, it has established its claims as a Gasteropod. There are also traces of alliance with some of the inferior classes. The red blood and vermiform configuration of the posterior part of the animal show some of the characters of the Annelida."

Two species of the genus are recognised as British, *D. entalis*, the Smooth Tusk, and *D. Tarentinum*, the Grooved Tusk. Of these the former is common around the shores of Scotland and the north of England; the latter on our southern coasts. Though possessing much resemblance to each other, they may be distinguished by the small end of the latter being finely grooved lengthwise, while the former is quite smooth and shining.

The Smooth Tusk, here represented, grows to a length of nearly two inches, with a diameter of about a quarter of an inch at the larger end. It is opaque, of a shining white surface, like porcelain, never tinged (as its southern congener usually is) with pink, and never marked with sculpture, but often with rings indicating the progress of growth.


DENTALIUM TARENTINUM, (*magnified*).

It is a deep-water species, living "buried in sand or sandy mud, in from ten to one hundred fathoms;" but obtained most abundantly in from forty to seventy fathoms.

Dr. Gray remarks that the apices of the British specimens often appear to be either broken off, or to have fallen off of themselves, like the tips of those shells called *decollated*, as some of the *Helicidæ;* and he adds that when the tip is broken, the animal forms a slight tube within, which is more or less produced beyond the tip. Specimens in this condition have been described as distinct species. A parasitical worm, of the class Echinodermata, the *Sipunculus Bernhardus*, is frequently found inhabiting old and dead shells of the *Dentalium*, the mouth of which it closes, except a minute orifice, with a sort of mortar made with sand. This parasite has sometimes been mistaken for the original inhabitant of the shell.

CLASS IV. CONCHIFERA.

(*Bivalve Mollusks.*)

It needs but a glance at a Cockle or an Oyster, to perceive that it is an animal lower in the scale of existence than a Snail or a Periwinkle. The absence of anything like a head, of any distinct mouth, of jaws, or tongue, or other apparatus for selecting and seizing food, as well as of the organs of sensation, together with the limited power of locomotion, proves its inferiority; and this position is fully borne out by an investigation of its anatomy.

The first character that strikes us on looking at one of these Mollusks is, that it is enclosed, more or less completely, within a shell composed of two pieces, called *valves*, which commonly bear a close resemblance to each other. They are united at one portion of their outline by a hinge, which allows them to separate to a certain extent, while they can be, during the life of the animal, brought together with accuracy, and held in this position with great force.

If, now, we open the shelly valves, and examine the interior, of the common Scallop (*Pecten*), for instance, we see that each is lined with a delicate membrane, the edges of which meet in the same manner as those of the valves. These edges are slightly thickened, studded with coloured glands, and fringed with rows of close-set, thread-like, contractile tentacles. Proceeding now to separate these membranous leaves, which together compose the mantle, we find two pairs of other leaves, composed of radiating fibres of exquisite structure, attached to the body in one part, but elsewhere floating freely, so as to allow the surrounding water to bathe every part of their surface. These organs are the *gills*, and, on being examined with the microscope, show how beautifully their exquisite structure is contrived for the maintenance of a constant current of water over them. Each of the four leaves is then seen to consist of a vast number of straight slender transparent filaments, evidently tubular, arranged side by side, so that 1,500 of them would be contained within the length of an inch. Strictly, however, these are but *one filament*, excessively long, bent upon itself again and again, at both the free and the attached end of the gill-leaf, throughout its whole extent. This repeated filament is armed on each of two opposite sides with a line of vibrating cilia, the two lines moving in contrary directions; by the action of which a current of water is made continually to flow up and down each of these delicate filaments; so that the blood which circulates in their interior (for they are doubtless blood-vessels) is continually exposed throughout this its long and tortuous course to the action of oxygen.

Like all organic functions, the action of these cilia is not under the will of the animal. It is said that if, during life, a small portion of the gills be cut off, the motion of the cilia will convey the fragment swiftly away, with a smooth easy motion, through the surrounding fluid in a definite direction. It does not even cease with the life of the animal. A specimen which I examined had been dead at least fifteen hours, yet when I placed the torn fragments of the branchiæ, one after another, beneath the microscope, the energy of the ciliary action, as the wave flowed with uniform regularity up one side and down the other of every filament, filled me with astonishment. Even the next morning, twenty-six hours after death, when the tissues of the filaments were partially dissolved, the ciliary motion was still going on, on portions that preserved their integrity.

In a sort of hood formed by the union of the gill-leaves at their basal part, is placed the entrance of the stomach; a simple orifice without jaws, teeth, or tongue, but bordered by four thin, membranous lips.

The force with which the valves resist our attempts to open them, during the life of the animal, depends on the presence of a large and powerful muscle, which is very apparent when they are opened, as it occupies a considerable portion of the interior, stretching directly from one valve to the other, and inserted by a broad base into each. By the contraction of the fibres which compose this muscle, the valves are strongly pulled together, and it is by cutting across this with an inserted knife that an oyster is commonly opened. When death ensues, the valves open spontaneously from another cause; muscular contraction then ceases, and the relaxed fibres can no longer resist the expansive force of a dense and highly elastic substance placed at the back of the shell close to the hinge, and known as the *ligament*.

Around this great muscle are grouped the stomach, liver, intestine and other vital organs; while in the neighbourhood of the mouth there is usually found a fleshy organ capable of being protruded beyond the limits of the shell, and of assuming various forms, suited to the different offices which it has to perform. This organ, which is small in the *Pecten*, is, in other genera, as the common Cockle, for example, developed to a very large size; while in others, as the Oyster, no trace of its presence is to be found. It is commonly known as the *tongue* or *foot*.

The current which plays over the gills subserves also another purpose, not less necessary to life. I have already said that the Bivalve Mollusca are unprovided with any organs for pursuing or seizing prey; and yet their food is largely animal. It consists principally of those minute creatures belonging to the Class *Infusoria*, which, invisible to the unassisted eye, swarm in innumerable millions in the waters both of the sea and of rivers. The currents which pour across the gills are crowded with these minute creatures, and the parts that surround the mouth lying in their course, and being themselves also clothed with vibratory cilia, a portion of the stream is drawn into the gullet and passes into the stomach, carrying with it the tiny prey, on which the Mollusk fattens, without any exertion of its own, for the ciliary action is doubtless, to a considerable extent, involuntary.

As far as is at present known all the members of this class are hermaphrodite; that is, the reproductive organization, instead of being assigned to two sexes, is perfect in every individual animal. In the Oyster, the ovary may be seen through the mantle, resting, as a whitish mass of considerable size, upon the muscle. It occupies the whole upper part of the animal, and creeps down along the sides and lower parts, being filled, at the time of reproduction, with a milky fluid containing multitudes of small granules of a whitish colour. These are the eggs; and in many of the family they are not at the time of their exclusion abandoned at once, but are deposited between the membranes of the gill-leaves, where they undergo a kind of incubation. In some, the shell is developed in the egg before it quits this receptacle. This fostering of the eggs seems to be analogous to the gestation of the eggs in the Crustacea and the Pipe-fishes.*

I have hitherto spoken of but a single adductor muscle, but in a large number of species there is a second, placed near the front part of the animal. This variation naturalists have used to divide the Class into two Orders, denominated *Dimyaria* and *Monomyaria*, or respectively Double and Single-muscled Bivalves. These characters can be determined at a glance by looking at a single valve of any shell; for the place of attachment of the adductor muscle is marked by a distinct sunken impression in the interior of each valve. From this circumstance also, these impressions, by the differences in their form, position, and dimensions, afford excellent characters for the discrimination of genera.

The accompanying figure, representing the interior of one of the valves of a common shell, will serve to illustrate the appearance of the muscular impressions, as well as of some other parts that are commonly mentioned in technical description. The oval mark on the left-hand side of the figure is *the front muscular impression;* the pear-shaped mark on the opposite side is the *hinder* one; the bending line which connects them is called the *pallial impression*, or that which marks the attachment of the mantle. On the upper side

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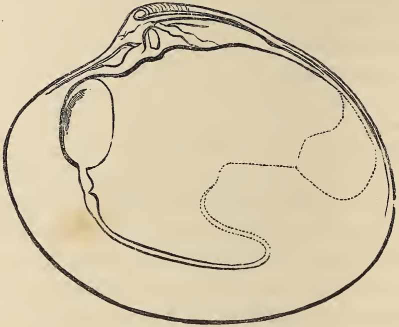
* Penny Cyclop. vii. 432.



VALVE OF CYTHERÆA.

is seen the *hinge*, an apparatus of shelly teeth alternating with cavities, which fit, with the most accurate precision, corresponding cavities and teeth in the opposite valve. The very summit of the shell, which often, as in this instance, projects into a blunt point, bending towards one side, is termed the *beak* or *umbo;* beneath this, on the anterior side, or that towards which it turns, there is a depressed space, often very conspicuous, termed the *lunule;* while on the hinder side of the *umbo* is spread the dense elastic leathery *ligament.* The *lunule*, *umbo*, and *ligament*, constitute the *dorsal* or *superior border*, the lower side (in the figure) is the *ventral* or *inferior border;* a line drawn from one to the other of these measures the *length* of the shell, the *width* being, of course, at right angles to this, while the *thickness* is determined by a line from the centre of one valve to that of the opposite.

ORDER I. MONOMYARIA.

FAMILY OSTREADÆ.

(*Oysters and Scallops.*)

On account of the beauty possessed by many members of this family, (a beauty comprising elegance of form, elaborate sculpture, and the most rich and brilliant colours,) their high development of organization, and, above all, the estimation in which they are held, and the extent to which they are consumed as human food, this must be considered as the most important of all the families of the *Conchifera*, or even of the *Mollusca*. Considerable variation, indeed, is found in the anatomy of these animals, and some of them entirely lack those organs which are found well developed in others; yet they possess so many characters in common, and glide into each other by gradations so close, that it is difficult to divide the group. All the tribe have the mantle widely open, no siphonal tubes, a single adductor muscle, and a ligament either entirely or in part concealed in the edge of the shell, lodged in a cardinal groove, and sometimes accompanied with teeth. In most cases there is a minute foot capable of spinning those threads which are called *byssus*, but this power is for the most part exercised only while the animal is young.

The Limes (*Lima*) and the Scallops (*Pecten*) are among the most active members of this Class of animals; they have been called the butterflies of the shell-fishes, a comparison not less apt on account of the delicacy and beautiful colouring of the wing-like shell, than of the agile motions which they exhibit. Though inhabitants of the deep sea, these bivalves take long and rapid leaps, shooting hither and thither, and fluttering about through the water with an irregular zig-zag movement, produced by the alternate opening and shutting of the valves with great force. The motions thus performed appear to be without any determinate direction, and to depend upon the impact of the valves upon the water; but these animals (the Pectens at least) have the power of effecting a more deliberate and precise locomotion, in the performance of which the mantle is the principal agent. The following observations, which I had recently an opportunity of making upon a young specimen of the Common Scallop or Quin (*P. opercularis*) which I was keeping in captivity, will serve to illustrate the form and office of the foot, as well as the faculty more immediately under consideration.

My attention was attracted to the Pecten by this curious circumstance, that it was adhering by one valve (the flat one) to the side of the glass phial, at some distance from the bottom. On close examination with a lens, I discovered that it was attached by a very delicate byssus. Curious to ascertain how it contrived to mount from the bottom to this position, I touched it slightly, and caused it to loose its hold. In the course of half an hour I found that it had resumed the same position again. I again disturbed it, and began to watch its motions. It was lying with the convex valve downwards on the bottom of the phial. The first thing I observed was the thrusting forth of the delicate little foot, an organ which seemed to me appropriately named, when I marked its close resemblance in form to a human foot and leg, enveloped in a white stocking. What I may call the sole of this tiny foot was pressed against the side of the glass, feeling about from place to place; while with the lens I could distinctly see, in the part corresponding to the toe, the opening of the fleshy lips, or sides of the grooves, in which the threads of byssus are said to be formed. While it was thus engaged my surprise was excited by seeing it suddenly throw itself with a jerk into an upright position; but the action was too startling to allow me to see how it was performed. I again laid it prone, and though for a moment it closed the valves, it presently opened them again, and performed a similar feat. This was followed by several leaps in different directions, in quick succession; but I was still at a loss to know the *modus operandi.* It appeared to me certain, that the ordinary supposition, viz. that the action is performed by the vigorous opening and shutting of the valves, was not the correct one. At length a favourable observation gave me a suspicion of the truth. I perceived the lips of the mantle (which were held in contact, though the valves were considerably separated) suddenly open to a partial extent, *as if by a blowing from within.* At this instant there was a leap in the opposite direction, attended with a considerable agitation in the water. With this clue I observed more definitely. Having rendered the water a little turbid, in order the more distinctly to see any motion of the particles suspended in it, several leaps confirmed the notion that had suggested itself to me. The mode of proceeding is as follows: when the Pecten is about to leap, it draws in as much water as it can contain within the mantle, while the lips are held firmly in contact. At this instant the united edges of the lips are slightly drawn inward, and this action gives sure warning of the coming leap. The moment after this is observed, the animal, doubtless by muscular contraction, exerts a strong force upon the contained water, while it relaxes the forced contact of the lips at any point of the circumference, according to its pleasure. The result is, the forcible ejection of a jet of water *from that point*; which, by the resilience of its impact upon the surrounding fluid, throws the animal *in the opposite direction*, with a force proportioned to that of the *jet d'eau*. The action may be well imitated by the human mouth blowing a stream of air from any determined point, while the lips are held firmly together at all other points. The resemblance, indeed, of the mantle to the human lips performing such an action, (a resemblance perhaps more close than flattering,) struck me as ludicrously faithful. Nor was the appearance less suggestive of a pair of bellows without a nose, of which the valves were the covers, and the mantle the leathers, discharging their contents from any part of their sides.

The Oysters (*Ostrea*), on the other hand, are stationary; never moving from the spot where the egg is first deposited. Every one is aware that the shells are frequently found adhering in the firmest manner to rocks or stones, or to each other; the substance of the shell having been deposited upon the foreign body, so as to conform perfectly and minutely to every irregularity of its surface. "The shelly case of the Oyster," observes Sir Anthony Carlisle in his eloquent oration, "is its sole security, and a superior delicacy of touch, diffused over the whole of the living surfaces, warns the creature of every danger, and bids the closing of senseless valves. The inward organization is equally simple with the exterior forms, and both are suited to a passive life; for locomotive beings demand evidences of distant things,—sometimes to supply their wants, and on other occasions to inform them of danger; but a stationary creature, being doomed to rely on its fixed resources, would only be tantalised by evidences placed beyond its control." *

In the Pectens, the edges of the mantle are furnished with eyes and tentacles; the Limes have the latter greatly developed, but the former organs are wanting, or very minute; the Oysters are destitute of both eyes and tentacles. The appearance of the eyes of the common Pecten has been already described (see p. 5). If we examine one of these organs under a microscope, say with a power of 220 diameters, we distinctly perceive it to be composed of a large globose lens, invested in a transparent coat, which is buried for more than half its volume in a socket of granular substance, and of a yellowish brown colour, having an ill-defined circle near its front part, of a blackish hue. This last, under continued pressure, bursts, and discharges a deep crimson pigment.

The genera composing this family are very extensive, and widely spread; particularly in the seas of warm and temperate climates. In general

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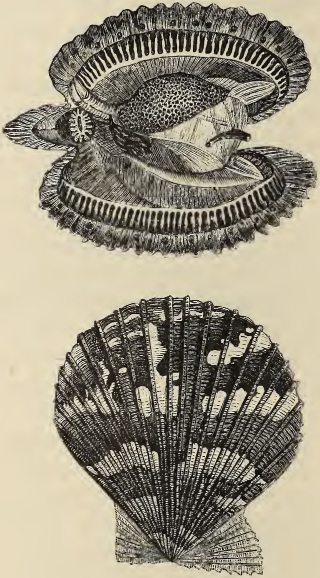
* Hunterian Oration, 1826.

they are eaten wherever found, and are highly sapid and delicate. The common Scallop (*P. opercularis*) is said to have derived its local name of *Quin* from the partiality which the celebrated epicure of that name manifested for it; and the



PECTEN.

Great Scallop or Frill (*P. maximus*), a much rarer species, is sought after for the London markets. "Scalloped with bread crumbs in its own shell, or fried with a little vinegar and pepper, it forms a very delicious morsel; it has the sweet flavour which characterizes all the scallops. The deep valves of this shell are much used to contain scalloped oysters, and in fishermen's huts for rude but useful lamps."*

Genus *Ostrea*.

The Oysters have a shell composed of two unequal valves, usually thick and irregular, connected by a hinge of the simplest character, without teeth. Externally the surface is rough, and composed of a great number of foliations loosely plaited, or marked with radiating furrows. The lower valve is more or less hollowed, the upper one flat.

The animal is shaped like the shell, having an open mantle with double edges, bordered by short fringes; the eyes, the tentacles, and the foot, are wanting.

We have but one British species, the Oyster, *par excellence* (*Ostrea edulis*), but the abundance and renown of this species compensate for the absence of others. The British Oysters were held in the highest estimation by the ancient Romans, who were even at the expense of bringing them to Rome for their luxurious feasts.† "Excellent as the oysters of Britain undoubtedly are, there are many degrees of that excellence, the animal varying much both in size and flavour, according to the nature of the coast, and the food with which the locality is furnished. The oysters on the south coast are generally very well flavoured;

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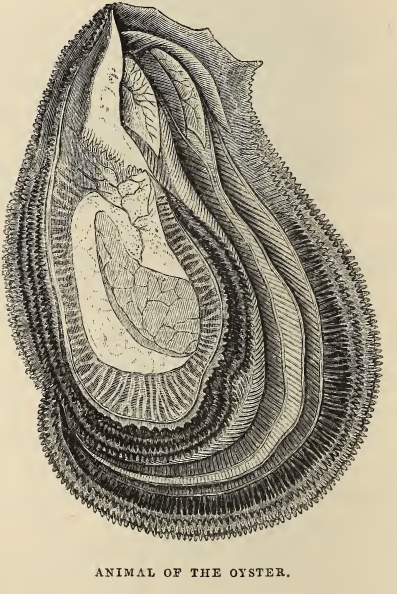
* Forbes and Hanley, ii. 298.

† Juvenal, Sat. iv. 140.

but it has been said that the best are found at Purfleet, and the worst at Liverpool. The Tenby oyster is large and rather coarse; but when fat is well-flavoured, and excellent when well stewed or pickled. Colchester, and other places in Essex, are the great nurseries or feeding-grounds for supplying the metropolis, and indeed, in a great measure, England generally, with this highly flavoured species. Here the Oysters collected at various places on the coast, even as far as Scotland, are brought, and laid on beds in creeks along



ANIMAL OF THE OYSTER.

the shore, where their flavour and size are rapidly improved. They have been known to augment the circumference of their shell even to the extent of an inch during the first two months, but in such cases the concavity within the valves is shallow."*

Almost all the information we yet possess on the economy of the Oyster, is derived from Bishop Sprat's "History of the Royal Society," and is contained in a paper entitled, "The History of the Generation and Ordering of Green Oysters, commonly called Colchester Oysters." It reads as follows:—

"In the month of May the oysters cast their spawn (which the dredgers call their spat); it is like to a drop of candle, and about the bigness of an halfpenny. The spat cleaves to stones, old oyster-shells, pieces of wood, and such like things at the bottom of the sea, which they call *cultch*. It is probably conjectured that the spat in twenty-four hours begins to have a shell. In the month of May, the dredgers (by the law of the Admiralty Court) have liberty to catch all manner of oysters of what size soever. When they have taken them, with a knife they gently raise the small brood from the cultch, and then they throw the cultch in again, to preserve the ground for the future, unless they be so newly spat that they cannot be safely severed from the cultch; in that case they are permitted to take the stone or shell, &c. that the spat is upon, one shell having many times twenty spats. After the month of May it is felony to carry away the cultch, and punishable to take any other oysters, unless it be those of size (that is to say) about the bigness of a half-crown piece, or when, the two shells being shut, a fair shilling will rattle between them. The places where these oysters are chiefly catched are called the Pont-Burnham, Malden, and Colnewaters. * * * This brood, and other oysters, they carry to creeks of the sea at Brickel-sea, Mersey, Langro, Fringrego, Wivenho, Folesbury, and Saltcoase, and there throw them into the channel, which they call their beds or layers, where they grow and fatten, and in two or three years the smallest brood will be oysters of the size aforesaid. Those oysters which they would have green, they put into pits about three feet deep in the salt-marshes, which are overflowed only at spring-tides, to which they have sluices, and let out the sea-water until it is about a foot and a half deep. These pits, from some quality in the soil co-operating with the heat of the sun,* will become green, and communicate their colour to the oysters that are put into them in four or five days, though they commonly let them continue there six weeks or two months, in which time they will be of a dark green. . . .

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* Penny Cyclop. xvii. 363.

" The oysters, when the tide comes in, lie with their hollow shell downwards; and when it goes out they turn on the other side. They remove not from their places unless in cold weather, to cover themselves in the ooze. The reason of the scarcity of oysters, and, consequently, of the dearness, is because they are of late years bought up by the Dutch. There are great penalties by the Admiralty Court laid upon those that fish out of those grounds which the court appoints, or that destroy the cultch, or that take any oysters that are not of size, or that do not tread under their feet, or throw upon the shore, a fish, which they call a five-finger, resembling a spur-rowel, because that fish gets into the oysters when they gape, and sucks them out.... The oysters are sick after they have their spat; but in June and July they begin to mend, and in August are perfectly well. The male oyster is black sick, having a black substance in the fin. They are salt in the pits, salter in the layers, saltest at sea."

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* Rather from the abundant increase in such pits of the green *Infusoria* and *Desmideæ,* on which the Oyster feeds.

For the most recent information respecting the oyster-beds which supply the London market, the extent of the supply, and the opinions of those practically concerned in their management and in the sale of their products, on points in the history and value of what may be termed cultivated oysters, we are indebted to Messrs. Forbes and Hanley, who obtained it from gentlemen of practical experience in the trade. From their valuable History of the British Mollusca the following particulars are extracted:—

"The oyster-beds from which the principal supply for the London market is procured, are those of Whitstable, Rochester, Milton, Colchester, Burnham, Faversham, and Queenborough, all artificial beds, furnishing *natives.* Since the introduction of steam-boats and railroads, considerable quantities of sea-oysters are brought from Falmouth and Helford, in Cornwall, from the coast of Wales, the Isle of Wight and its neighbourhood in Sussex, and even from Ireland and Scotland, after the winter sets in, as before they would not keep fresh enough when brought from long distances. The supply derived from natural beds varies much, since on some of them the oysters are not sufficiently abundant to pay for dredging. The sea-oyster is often, before being brought to market, kept for a time in artificial beds, in order to improve its flavour.

"The most esteemed oysters are those of the small ovate, but deep-shelled variety, called Natives, among which, those of the river Crouch, or Burnham Oysters, are pre-eminent for the marine flavour; probably on account of the facilities for rapid importation of them in fine condition. Much of the quality depends on the ground and condition of the beds: the oysters of different years from the same place often vary materially in this respect. They are considered full-grown for the market when from five to seven years old; sea-oysters at four years. The age is shown by the annual layers of growth, or 'shoots,' on the convex valve. Up to three or four years, each annual growth is easily observed, but after their maturity it is not so easy to count the layers. Aged oysters become very thick in the shell. In the neighbourhood of fresh water the oyster grows fast, and improves in body and flavour. The flavour is said by some to improve by shifting the oysters as they approach their full growth. Frost kills numbers, and when they are left dry at low ebbs, the run of fresh water from the land turns them, what is called, 'foxy,' of a brownish red colour. They are sometimes seized with sickness during the spawning season, and considerable numbers may die. Much labour is required to keep the beds in good order, cleansed from shells and rubbish, star-fishes, barnacles, corallines, and sea-weed, which grow freely in the spring of the year. On the cleanliness of the ground the prolific character of the bed, if the oysters breed there, depends. If carefully attended to, a bed may last any length of time; but if neglected, it will become overgrown with weed and buried in mud, so that it can only be reclaimed by restocking at a great expense, or is altogether destroyed. Artificial beds, for the purpose of keeping a supply at hand for the London market, are said to have been commenced about the year 1700, by the Kent and Essex Companies of Dredgers. The oyster does not breed freely, often not at all, on artificial beds, so that they require to be constantly restocked; and when they do spawn under such circumstances, the fry are said seldom to come to perfection. On their natural grounds they spawn profusely during the season, *i.e.* during the summer months."

The nature of the "spat" is thus explained by Sir Anthony Carlisle: "Oysters are viviparous, and the young are found within the tracheal passages, and between the folds of the coverlit (mantle), during the months of June and July in this climate. In its first state the oyster exhibits two semi-orbicular films, of transparent shell, which are continually opening and closing at regular intervals. The whole brood are associated together by being involved in a viscid slime, and in that state called the spat; it being common among viviparous animals of this kind to have their spawn deposited in contact with the lungs; the involving slime serves as the first nutriment, and we may infer, that the fœtal food so influenced by the gills is, at the same time, a respiratory supply to the imperfectly formed young."*

"In London the chief consumption of common oysters is from the 4th of August to January, and of natives from October to March. The consumption is said to be greatest during the hottest months after the commencement of the oyster season; the warmer the weather, the more oysters are consumed. They are brought to market in craft of various sizes; they are packed in bulk closely in the hold; in some cases a cask of salt-water is kept, from which to sprinkle them superficially. Those that come by rail are packed with the convex shells downwards, in bags or barrels. From the boats they are transferred to the salesmen, who keep them in a little salt and spring water, and shift them every twelve hours. Some pretend to improve them by 'feeding' them on oatmeal. Oysters, like other bivalves, live chiefly on infusoria. The quantity consumed annually in London varies in different seasons. One informant states twenty thousand bushels of natives, one hundred thousand bushels of common oysters, to be about the mark: another estimates the quantity sold in the season, from the 4th of August to the 12th of May, to be nearly one hundred thousand London bushels; each bushel being three Manchester, or imperial, bushels; and that about thirty thousand bushels of natives are sold during the same period by various Companies. During the season, commencing on August the 4th, 1848, and ending May 12th, 1849, Mr. Wickenden estimates about one hundred and thirty thousand bushels of oysters to have been sold in London, though of that quantity about one fourth was sent away to various parts of the United Kingdom and the Continent." *

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* Hunterian Oration, 1826.

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* Forbes and Hanley, ii. 315.

Family Aviculadæ.

(*Pearl Shells.*)

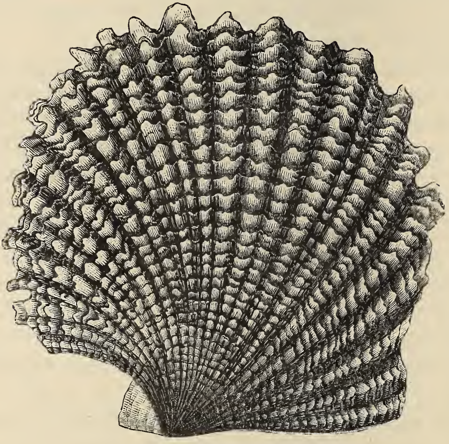
The members of this family effect a transition from those genera which have but a single muscle, to those which have two; for though their shells display two, or even more muscular impressions, one is always found to predominate greatly over the rest, which are but small.

The shell has its exterior portion commonly black, or of the colour of horn, and composed of prismatic cellular substance; the interior layers are composed of nacre, and are therefore brilliantly pearly. Their form is very irregular, the valves being unequal, and always developed more towards one side than the other. The hinge is without teeth, the ligament thin, simple, or notched.

The animals have a mantle which does not adhere to the shell, entirely open all round, prolonged into irregular lobes, without siphons; there is a small foot which is grooved, and capable of spinning a strong byssus.

The most important genus of the family contains the Wing-shells, one species of which is the Pearl-oyster, from the interior shell of which we obtain the substance known as mother-of-pearl, which is largely imported into this country, and manufactured into shirt-buttons, knife-handles, and various trinkets; it is also much used for ornamental inlaying. But that which renders this shell of much more value is the production of pearls, the beauty of which has always rendered them fit companions of the choicest precious stones, for the purpose of personal adornment.

Pearls are indeed produced by several genera of shells both bivalve and univalve, but the most precious are obtained from the species named *Avicula margaritifera*, which is a native of the Indian Ocean. On the coast of India and Persia numerous fisheries are established, which supply the markets of the world with precious pearls. Some of these have been carried on from very ancient times; that for example at Catifa in Arabia, which produced the celebrated pearl bought by Tavernier for 110,000*l.*, is mentioned by Pliny.



AVICULA.

The most productive fisheries are prosecuted in the Persian Gulf, and on the coast of Ceylon; that of the Bahrein Islands, in the former locality, often produces pearls to the value of 90,000*l.* sterling in two months, the time in which it is prosecuted. This is free to all adventurers on payment of the tax, but the fishery of Ceylon is a monopoly in the hands of government.

A very interesting and graphic account of this fishery is given by Captain Percival, from whose "History of Ceylon" the following particulars are extracted.

"There is perhaps no spectacle," says the author, "which the island of Ceylon affords more striking to a European than the Bay of Condatchy during the season of the pearl fishery. This desert and barren spot is at that time converted into a scene which exceeds, in novelty and variety, almost anything I ever witnessed: several thousands of people of different colours, countries, castes and occupations continually passing and repassing in a busy crowd; the vast numbers of small tents and huts erected on the shore, with the bazaar or market-place before each; the multitude of boats returning in the afternoon from the pearl banks, some of them laden with riches; the anxious expecting countenances of the boat owners, while the boats are approaching the shore, and the eagerness and avidity with which they run to them when arrived, in hopes of a rich cargo; the vast numbers of jewellers, brokers, merchants of all colours and all descriptions, both natives and foreigners, who are occupied in some way or other with the pearls, some separating and assorting them, others weighing and ascertaining their number and value, while others are hawking them about or drilling and boring them for future use,—all these circumstances tend to impress the mind with the value and importance of that object which can of itself create this scene.

"The Bay of Condatchy is the most central rendezvous for the boats employed in the fishery. The banks, where it is carried on, extend several miles along the coast from Manaar southward off Arippo, Condatchy and Pomparipoo. The principal bank is opposite to Condatchy, and lies out at sea about twenty miles. After the survey of the state of the beds, and the consequent report to Government, the particular banks to be fished are put up for sale to the highest bidder, and are usually purchased by a black merchant. The Government, however, sometimes judges it more advantageous to fish the banks on its own account, and to dispose of the pearls to the merchants.

" The banks are divided into three or four different portions, which are fished annually in succession. These portions are distinct, and are set up separately to sale, each in the year in which it is to be fished. A sufficient interval is thus given to the oysters to attain their proper growth; and as the portion first used has generally recovered its maturity by the time the last portion has been fished, the fishery becomes almost regularly annual, and may thus be considered as yielding a yearly revenue. The oysters are supposed to attain their complete state of maturity in seven years.

" The fishing season commences in February, and ends about the beginning of April. The period allowed to the merchant to fish the banks is six weeks, or two months at the utmost; but there are several interruptions which prevent the fishing days from exceeding more than about thirty. If it happen to be a very bad season, and many stormy days intervene during the period allotted, the purchaser of the fishery is often allowed a few days more. . . .

"A signal gun is fired at Arippo about ten o'clock at night, when the whole fleet sets sail with the land-breeze. They reach the banks before daybreak, and at sunrise commence fishing. In this they continue busily occupied till the sea-breeze, which arises about noon, warns them to return to the bay. As soon as they appear within sight, another gun is fired, and the colours hoisted, to inform the anxious owners of their return. When the boats come to land, their cargoes are immediately taken out, as it is necessary to have them completely unloaded before night. Whatever may have been the success of their boats, the owners seldom wear the looks of disappointment; for although they may have been unsuccessful one day, they look with assurance of better fortune to the next; as the Brahmins and conjurors, whom they implicitly trust, in defiance of all experience, understand too well the liberality of a man in hopes of good fortune, not to promise them all they can desire.

"Each of the boats carries twenty men, with a tindal, or chief boatman, who acts as pilot. Ten of the men row and assist the divers in re-ascending. The other ten are divers; they go down into the sea by five at a time; when the first five come up, the other five go down, and by this method of alternately diving, they give each other time to recruit themselves for a fresh plunge.

"In order to accelerate the descent of the divers, large stones are employed: five of these are brought in each boat for the purpose; they are of a reddish granite, common in this country, and of a pyramidal shape, round at the top and bottom, with a hole perforated through the smaller end sufficient to admit a rope. Some of the divers use a stone shaped like a half-moon, which they fasten round the belly when they mean to descend, and thus keep their feet free.

"These people are accustomed to dive from their very infancy, and fearlessly descend to the bottom in from four to ten fathoms water in search of the oysters. The diver, when he is about to plunge, seizes the rope to which one of the stones we have described is attached, with the toes of his right foot, while he takes hold of a bag of network with those of his left, it being customary among all the Indians to use their toes in working or holding as well as their fingers; as, such is the power of habit, they can pick up even the smallest thing from the ground with their toes almost as nimbly as a European could with his fingers. The diver, thus prepared, seizes another rope with his right hand, and holding his nostrils shut with the left, plunges into the water, and by the assistance of the stone speedily reaches the bottom. He then hangs the net round his neck, and, with much dexterity and all possible despatch, collects as many oysters as he can while he is able to remain under water, which is usually about two minutes; he then resumes his former position, makes a signal to those above by pulling a rope in his right hand, and is immediately by this means drawn up and brought into the boat, leaving the stone to be pulled up afterwards by a rope attached to it."

The serious effects which so protracted a submersion must produce upon the human frame, are manifested by a discharge of water from their mouths, ears, and nostrils, and frequently of blood. But this does not hinder them from going down in their turn. "They will often," continues our author, "make from forty to fifty plunges in one day, and at each plunge bring up about a hundred oysters. Some rub their bodies over with oil, and stuff their ears and noses to prevent the water from entering, while others use no precautions whatever. Although the usual time of remaining under water does not much exceed two minutes, yet there are instances known of divers who could remain four or five minutes, which was the case with a Caffre boy the last year I visited the fishery. The longest ever known was that of a diver who came from Anjango in 1797, and who absolutely remained under water full six minutes."

The last named period seems almost incredible, but there is no reason to doubt Captain Percival's evidence. The chief horror and danger awaiting the diver are concentrated in the ground-shark. This animal is a common and fearful inhabitant of all the seas in these latitudes; and its terrors are so continually before the eyes of the divers, that they seek a vague safety in supernatural means. Before they begin diving, the priests or conjurors, who are known in the Malabar language by the name of Pillal Karras, or binders of sharks, are always consulted, and whatever the conjuror says to them is received with the most implicit confidence.

The divers are paid differently, according to their private agreement with the boat-owners, either in money, or with a proportion of the oysters caught, which they take the chance of opening on their own account; the latter is the method most commonly adopted. The agreements with the people who hire out the boats are conducted much in the same manner. They contract either to receive a certain sum, or permission to fish on their own account. Some of those who pursue the latter plan are very successful, and become rich, while others are great losers by the speculation. The spirit of gambling is more openly exhibited, for oyster lotteries are carried on to a great extent, and they consist of purchasing a quantity of the oysters unopened, and running the chance of either finding or not finding pearls in them. These lotteries are great favourites with European officers and gentlemen. The boat-owners and the merchants lose some of the best pearls while the boats are on their return to the bay from the banks, as the oysters when alive, and left for a time undisturbed, frequently open their shells of their own accord; a pearl may then be easily discovered, and the oyster prevented, by means of a bit of grass, or soft wood, from again closing its shell, till an opportunity offers of picking out the pearl.

Captain Percival thus concludes his interesting account:—" As soon as the oysters are taken out of the boats, they are carried by the different people to whom they belong, and placed in holes or pits, dug in the ground to the depth of about two feet, or in small square places, cleared and fenced round for the purpose, each person having his own separate division. Mats are spread below them to prevent the oysters from touching the earth, and here they are left to die and rot. As soon as they have passed through a state of putrefaction, and have become dry, they are easily opened, without any danger of injuring the pearls, which might not be the case if they were opened fresh, as at that time to do so requires great force.

On the shell being opened the oyster is minutely examined for the pearls; it is usual even to boil the oyster, as the pearl, though commonly found in the shell, is not unfrequently contained in the body of the fish itself.

"The stench occasioned by the oysters being left to putrefy is intolerable, and remains for a long while after the fishing is over. It corrupts the atmosphere for several miles round Condatchy, and renders the neighbourhood of that country extremely unpleasant till the monsoons and violent south-west winds set in and purify the air. The nauseous smell, however, is not able to overcome the hope of gain; for months after the fishing season, numbers of people are to be seen earnestly searching and poring over the sands and places where the oysters had been laid to putrefy; and some are now and then fortunate enough to find a pearl that amply compensates their trouble in searching after them. In 1797, while Mr. Andrews was collector, a coolie, or common fellow of the lowest class, got by accident the most valuable pearl seen that season, and sold it to Mr. Andrews for a large sum.

"The pearls found at this fishery are of a whiter colour than those got in the Gulf of Ormus, on the Arabian coast, but in other respects are not accounted so pure, or of so excellent a quality; for though the white pearls are more esteemed in Europe, the natives prefer those of a yellowish or golden cast. Off Tutucoreen, which is on the Coromandel coast, nearly opposite to Condatchy, there is another fishery; but the pearls found there are much inferior to those two species I have mentioned, being tinted with a blue or greyish tinge.

"In preparing the pearls, particularly in drilling and stringing them, the black people are wonderfully expert. I was very much struck with the instrument they employ in drilling, as well as the dexterity with which they use it. A machine made of wood, of a shape resembling an obtuse inverted cone, about six inches in length and four in breadth, is supported upon three feet, each twelve inches long. In the upper flat surface of this machine holes or pits are formed to receive the larger pearls, the smaller ones being beat in with a wooden hammer. The drilling instruments are spindles of various sizes, according to that of the pearls; they are turned round in a wooden head by means of a bow-handle to which they are attached. The pearls being placed in the pits which we have already mentioned, and the point of the spindle adjusted to them, the workman presses on the wooden head of the machine with his left hand, while his right is employed in turning round the bow-handle. During the process of drilling he occasionally moistens the pearl, by dipping the little finger of his right hand in a cocoa-nut filled with water, which is placed by him for that purpose; this he does with a dexterity and quickness which scarcely impede the operation, and can only be acquired by much practice.

"They have also a variety of other instruments both for cutting and drilling the pearls. To clean, round, and polish them to that state in which we see them, a powder made of the pearls themselves is employed. These different operations in preparing the pearls, occupy a great number of the black men in various parts of the island. In the black town or *pettah* of Columbo, in particular, many of them may every day be seen at this work."

GENUS *PINNA*.

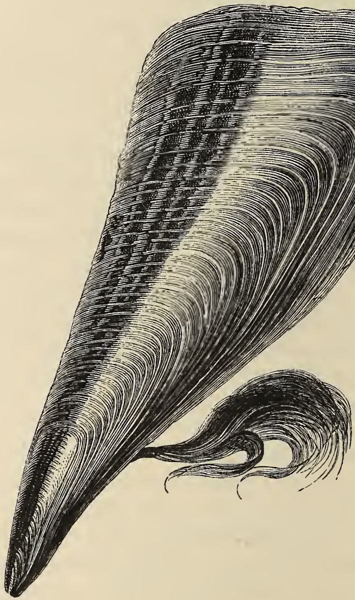
The largest British bivalves belong to the genus *Pinna*, in which the shell is fibrous, and horny in texture, rather fragile and delicate; the valves are equal, triangular and exceedingly one-sided; the hinge is straight, long and toothless, the ligament marginal, and almost wholly internal.

The animal is triangular, with the mantle freely open and having fringed edges; the foot is small, conical, or tongue-like, and grooved; there is a small anterior muscle in the angle; the posterior one is by far the larger.

The genus contains but few species, which are, however, widely distributed, and most of them are of large size; they range from deep water to near the shore, living on sandy or muddy bottoms, with their beaks plunged deep into the ground, and the broad extremity gaping upwards.

In a cabinet of British shells the eye is sure to be attracted by the great fan-like horny valves of the Pinna (*Pinna pectinata*), which are not uncommonly seen twelve inches long, and seven broad at the gaping end. Young specimens are of a semi-transparent horny texture, partially covered with rows of hooked spinous scales; but these spines are almost always worn away in old examples. The interior is pearly in a slight degree, and loose pearls of dull colour are sometimes found within the shells. The silky byssus spun by these mollusks, which is capable of being woven into small articles of wearing apparel, has been already noticed.

The great Pinna is found all around the British coast, chiefly in deep water. Montagu found a bed of them in Salcomb Bay, which was occasionally accessible when the tide receded beyond its usual limits. The valves stood upright, with the broader



PINNA.

end about an inch above the surface, and the lower end fixed so firmly to the soil by a very large strong byssus two or three inches in length, composed of numerous fine silky fibres of a dark purplish brown hue, as to demand the exercise of considerable force for their removal.

Mr. Couch, in his "Fauna of Cornwall," observes that "this species is found in the greatest abundance at the distance of from three to six leagues south of the Deadman Point, where they stud the bottom in multitudes, with only two or three inches of the pointed end inserted into the soil. It is common for the line or hook to become entangled among these shells, and powerful effort is required to drag them from their attachment, which is only effected by breaking the byssus, or tearing away the ground to which it is attached. In the latter case a rich harvest of shells is often afforded, but the pointed end of the Pinna is usually broken off by the violence. It is perhaps owing to the different degree of solidity of the ground, that the shells living in the deeper water are so much less buried than those of which Montagu speaks, and one of the consequences may be a greater degree of motion in the shell. Montagu observes that the exposed end cannot be closed by art, but the animal is capable of effecting it; and observation has taught me, that this is its method of obtaining food. In its ordinary position this opening is about two inches wide, exposing the contained animal, which occupies but a small portion of the cavity, and seems to offer itself a prey to the first creature that may choose to devour it. Some fish is thus tempted to enter, but the first touch within is a signal for its destruction. The shell closes not only at the side but at the top, the latter action being effected by a separation of the pointed ends, and the captive is either crushed to death, or soon perishes from confinement."

ORDER II. DIMYARIA.

FAMILY ARCADÆ.

(*Arks.*)

A WELL marked character of this family, and one that a glance is sufficient to recognise, is the peculiarity of the hinge. This, whether straight or bent, extends along a large portion of the margin of each valve, and is formed of a great number of minute comb-like teeth arranged in a row, nearly parallel to each other, or slightly diverging. Those of one valve correspond in shape and size to those of the other, with which they accurately interlock. The beaks (*umbones*) are generally distant from each other when the shell is closed. In form, size, solidity, sculpture, and colour, there is much diversity in the species; but all are covered with an epidermis. Two distinct muscular impressions are strongly marked, which are remote from each other, but are connected by a line running parallel to the border of the valve, which is the pallial impression.

The animal has the mantle freely open, without siphonal tubes, except in a few species. It is partially adherent to the shell; sometimes prolonged backwards. The foot is always considerably developed, deeply grooved, and capable of expanding into a disk, like that of a Gasteropod.

All the species are marine, and inhabit various depths of water from tide-marks outwards. Some of them affix themselves firmly to rocks, by means of a stout byssus.

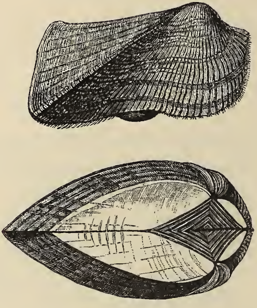
GENUS *ARCA*.

From the square boat-like form of the valves in this genus, resembling that commonly attributed in engravings to the Ark of Noah, these shells have derived their name. The valves are generally equal, much broader than long, and more developed on one side than on the other; four-sided in outline, and usually solid in texture. Their surface is covered with radiating close-set grooves, concealed, however, by a rough, loose, horny epidermis. The hinge is nearly or quite straight; consisting of numerous minute teeth, which are parallel in the centre, but diverge at the sides.

The animal is oblong; the mantle, which, as stated above, is open, is either fringed or simple at its edges. The foot is large, oblong, bent, grooved throughout, and capable of expanding into a disk, with plain, or slightly plaited edges; it is furnished at its base with a gland from which is spun a strong compact byssus. The mouth is surrounded by lips, which are formed by the extremities of the gills.

These Mollusks inhabit all depths of water, but are generally found near the shore; perhaps, however, this is because their peculiar habits render them less accessible in other situations. They chiefly live in holes and fissures of rocks, moored by their powerful byssus. M. Rang remarks that they sometimes adhere by their disk-like foot: and Mr. Swainson states, that when young, they occasionally adhere by means of their fibrous epidermis.

The species of this genus are chiefly distributed through the seas of the tropics, where they are very numerous. We have three or four on our own shores, the largest of which is commonly known as the Ark of Noah, though the species properly so named (*Arca Noœ*) is a native of the Mediterranean. Ours is the *Arca tetragona* of conchologists. The valves are deep, four-sided, and strongly angular, covered with fine radiating lines, of a warm reddish-brown hue, becoming paler and sometimes white on the front part. The valves sometimes attain a breadth of two inches, with a length of about three-fourths of an inch. It is found commonly all round the British coasts, most abundantly in the south-west, and in the extreme north. "It is taken in crevices of rocks, in chinks of old shells, in the interior of dead shells, and sometimes quite free. When found in con-



NOAH'S ARK.

fined localities it is often much distorted, but free specimens are very regular."* The epidermis in this species often projects beyond the edges of the valves, in the form of a ragged fibrous fringe.

Family Mytilidæ.

(*Mussels.*)

The members of this family are almost all marine, though one genus (*Dreissena*) inhabits the rivers of Eastern Europe, and is now found plentifully in some of the navigable streams of this country, having been introduced, as is supposed, adhering to timber, or to the bottoms of ships. The distinctive characters of the family, as enumerated by M. de Blainville, are as follows:—

The shell is regular, with the valves equal but much lengthened, and produced on one side. The hinge is destitute of teeth; the ligament dorsal and linear. The texture of the shell is sometimes thin and horny, and it is often covered with an epidermis. There are two muscular impressions, the hinder of which is considerably larger than the other.

In the animal we find the mantle adhering towards the borders, but open throughout its inferior portion, with a distinct anal tube, but the branchial one rudimentary, and indicated only by a thickening of the posterior borders of the mantle. The foot is narrow and tongue-shaped, grooved down its centre, and furnished with a byssus backwards at its base. In some of the genera, as *Lithodomus*, a foreign group which burrow in the hardest rocks, the faculty of spinning is confined to the early life of the animal, but in others a strong and copious byssus is formed at pleasure through life.

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* Forbes and Hanley.

GENUS *MYTILUS.*

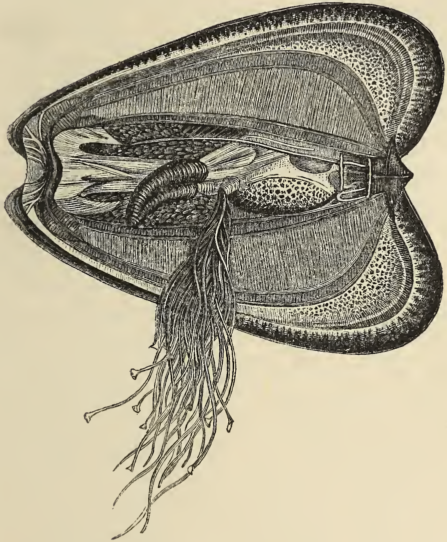
The name of this familiar shell-fish is derived from the obvious resemblance which its shell bears to a mouse, the united beaks representing the nose. The Greeks used the term Μῦς for both the shell and the quadruped, and both the Latin term *Mytilus* and our own *Mussel* are derived from that appellation.

The genus is characterised by a shell very unequal-sided, but equal-valved, somewhat triangular, running off into pointed terminal beaks, the valves swelling, the surface covered with a horny skin; the hinge, though sometimes notched, has no true teeth; the narrow ligament is internal.

The animal is lengthened and oval, the lobes of the mantle are simple or fringed, united behind in a single point, so as to form an anal siphon. The mouth is rather large, furnished with two pairs of soft lips. The foot is slender, strap-shaped, grooved, carrying at its base a silky byssus of considerable strength.

The Edible Mussel (*Mytilus edulis*) is the only British species, but is too abundant and too well known to need description. Sold in every town as an article of food, its three-sided shells, black without and blue within, and the bearded animal, both in its raw and cooked state, are familiar to every one.

Dr. Knapp of Edinburgh has communicated to Messrs. Forbes and Hanley a very interesting account of the quantities of this animal destroyed annually in the neighbourhood of that city. "As an article of food," he states, "there cannot be used fewer than ten bushels per week in Edinburgh and Leith, say for forty weeks in the year; in all, 400 bushels annually. Each bushel of mussels, when shelled and freed from all refuse, will probably contain from three to four pints of the animals, or about 900 or 1,000, according to their size. Taking the latter number, there will be consumed in Edinburgh and Leigh about 400,000 mussels. This is a mere trifle compared to the enormous number



MUSSEL.

used as bait for all sorts of fish, especially haddocks, cod, ling, halibut, plaice, skate, whiting, &c. In Newhaven alone there are four large deep-sea fishing-boats, which generally go out three times a-week, and fish for about thirty weeks in the year, excluding Sundays and bad weather. Each of these large boats carries eight men, with eight lines of 800 yards in length, which, at a low calculation, take 1,200 mussels to bait each time they are used; so that each large boat will use 28,800 mussels per week, equal to 864,000 per annum. But there are about sixteen other smaller boats, which go out daily, or rather at 12 o'clock every night, for about the same number of weeks in the year. Each carries four men, with four lines 800 yards long. Their consumption of mussels will come to 3,456,000. The total consumption of mussels for bait annually in Newhaven alone may be reckoned at 4,320,000. As there are nearly as many used at Musselburgh, and Fisherrow, Buckhaven, Elie, Anstruther, Pittenweem, Crail, and other places on the Frith of Forth, we may calculate that thirty or forty millions of mussels are used for bait alone by the fishermen of this district each year. Numbers come from the river Eden-on-Fife, and are sold at 25*s.* per cask. The best mussels at Newhaven are got directly north of the Pier, in three fathoms water, and are sold at 8*d.* per basket, each containing nearly a bushel. The beds are private property, and some of them having been injudiciously or avariciously exhausted, the number of mussels in the Forth has decreased, and the price increased, within the last ten years."

The eminent authors of the work just cited furnish us with some other particulars of interest.

"Mussels are kept in many places in artificial beds, to be used when required for bait. At Anstruther, in Fifeshire, we have seen these 'mussel gardens,' as they are called—little plots of seashore between tide-marks, edged in by stones, and held as private property. In Northumberland, Mr. Alder states, the fishermen build up piles of stones among the rocks, to keep their mussels safe."*

The Freshwater Mussel (*Unio*) has long been known as one of those shell-fish that produce pearls; but those procured from the present species are commonly small, ill-coloured, and of little value, though they have been at various times much sought for. The passage in Camden's "Britannia," about the pearls in Cumberland, evidently refers to these. "Higher up the little river that runs into the sea, . . . the shell-fish, having by a kind of irregular motion taken in the dew, which they are extremely fond of, are impregnated and produce pearls, or to use the poet's phrase, *baccæ cochleæ*, shell-berries, which the inhabitants, when the tide is out, search for, and our jewellers buy of the poor for a trifle, and sell again at a very great price." The attempt to account for the origin of pearls by the drinking in of dew-drops, my readers may probably think more poetical than philosophical. A very curious account of a recent pearl-fishery in North Wales is given by a correspondent in "Loudon's Magazine of Natural History" for 1830. The writer has confounded the *Mytilus edulis* with the *Unio*. To the latter only his remark on pearls "found up the river" applies. His account is as follows, with some slight omissions:—

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* Brit. Mollusca, ii. 174, *et seq.*

"The pearl-mussel is found in abundance in the river Conway, in North Wales, and is collected by many of the natives, who obtain their livelihood entirely by their industry in procuring the pearls. When the tide is out, they go in several boats to the bar at the mouth of the river, with their sacks, and gather as many shells as they can before the return of the tide. The mussels are then put into a large kettle, over a fire, to be opened, and the fish taken out singly from the shells with the fingers and put into a tub, into which one of the fishers goes barefoot and stamps upon them until they are reduced to a sort of pulp. They next pour in water to separate the fishy substance, which they call *solach*, from the more heavy parts, consisting of sand, small pebbles, and the pearls, which settle at the bottom. After numerous washings, until the fishy part is entirely removed, the sediment, if I may so term it, is put out to dry, and each pearl separated on a large wooden platter, one at a time, with a feather; and when a sufficient quantity is obtained, they are taken to the overseer, who pays the fisher so much an ounce for them. The price varies from eighteenpence to four shillings: there are a number of persons who live by this alone, and where there is a small family to gather the shells and pick out the fish, it is preferable to any other daily labour. The pearls are generally a dirty white, sometimes blue, but never, I believe, green or reddish. I cannot with accuracy say how many ounces are taken to the overseer each week, though I might say there are some scores. But what makes this fishery more singular, is the mystery which hangs over it. At present it is a perfect monopoly, and there is but the one who buys them up, that knows what becomes of them afterwards. It has been carried on in this manner for many years, and as such a thing, if made public, might prove more beneficial to the neighbouring poor, by causing a higher price to be given for the pearls, it would be more so if any of your numerous correspondents could throw some light on this interesting subject. There have been some curious and fanciful surmises, which may not be thought worth mentioning. Some suppose that the pearls are sent abroad to be manufactured into seed pearls; others, more gravely, that they are exported to India to be dissolved in the sherbet of the nabobs! However, at present it is a mystery; and, notwithstanding the pains taken and the expense incurred by some liberal gentlemen in endeavouring to find out the secret, it is as great a mystery as ever. The huts which have been erected for the convenience of boiling the fish, are on the extremity of the marsh, about a mile north of the town of Conway. The pearls are seldom found here much larger than the enclosed specimens, though about twelve miles up the river they have been found occasionally as large as a moderate-sized pea, and have been sold for a guinea the couple, but they are very rarely met with. When I say that the price varies from eighteenpence to four shillings, I do not mean to say that they are valued according to their size, for the large and small pearls are all sold together: but some years ago they were as high as four shillings, now they are only two shillings per ounce."

The ill effects produced by eating the mussel, at least at certain times, and on certain constitutions, have been before alluded to. (See ante, p. 43.) Such cases, however, are rare, and, as Pennant remarks, for one who is affected by eating mussels, a hundred remain uninjured. In general, they are simply boiled with us; but probably they might be made much more savoury by a different mode of cooking. Captain King, in speaking of a large species (*M. choros*) found abundantly on some islands on the Pacific coast of South America, observes:—"The manner in which the natives of these islands, both Indians and descendants of foreigners, cook shell-fish is similar to that used for baking in the South Sea Islands, and in some parts of the coast of New Holland. A hole is dug in the ground, in which large smooth stones are laid, and upon them a fire is kindled. When they are sufficiently heated, the ashes are cleared away, the shell-fish heaped upon the stones, and covered first with leaves or straw, and then with earth. The fish thus baked are exceedingly tender and good, and this mode of cooking them is superior to any other, as they retain within the shell all their own juiciness."

FAMILY UNIONIDÆ.

(*Freshwater Mussels.*)

From the true Mussels the transition is easy to those of this family. They are distinguished chiefly by the structure of the foot of the animal, which is greatly developed in dimensions, and, at least in general, has not the power of spinning a byssus. Mr. Anthony, however, a conchologist of the United States, where the great abundance of these Mollusks in the large rivers affords peculiar facilities for observation, has stated that under peculiar circumstances certain species do spin a byssus, both in the young and adult conditions.*

The shell is lengthened oblong, equal-valved, unequal-sided, though in a much less degree than the family last noticed. The interior is pearly, often very brilliant; the exterior is invested by a horny epidermis, which, though generally black or olive, is sometimes richly coloured. The hinge varies greatly, being sometimes destitute of teeth, and sometimes furnished with long ones. The muscular impressions are numerous, the ligament and cartilages are external.

The animal has the mantle free all round, except behind the hinder edges, forming, when in conjunction, two tubes, the larger of which is guarded by pointed and tooth-like tentacles. The foot is large, compressed, somewhat four-sided.

These Mollusks live at the bottoms of rivers and lakes, plunged perpendicularly into the mud, with the terminations of the siphons just exposed. They sink deeper when disturbed. Sometimes they are found under the shelter of stones in rivers with rocky bottoms.

The distribution of the family is peculiar. Very few are found in the Eastern Hemisphere, but all the rivers of America swarm with them. More than two hundred species are enumerated as inhabiting the United States.

The sexes of these animals are distinct, and may be distinguished by the shell in the female being more swollen than that of the male.

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* Ann. Nat. Hist. vi.

Genus *Unio.*

The condition of the hinge affords the distinctive character in this family. The genus *Unio* has it furnished with a short crested anterior tooth, and a lengthened posterior lateral one in the right valve, shutting between two similar teeth in the opposite.

The shells of this genus, which are frequently large and richly pearly in the interior, are frequently used by artists for containing their colours. One of our British species is hence named *Unio pictorum*, or the Painter's Unio. Many of them yield pearls, which are generally superior to those of the marine Mussels. Our finest native species, hence named *U. margaritiferus*, is one of these. It is about five inches long, and half as broad, somewhat kidney-shaped, covered with a black epidermis, usually worn away at the beaks; the interior is pearly, but not brilliant. This species inhabits the rapid streams of mountainous districts in various parts of the British Islands.

"The Pearl Mussel, as this mollusk is familiarly called, enjoys a distinguished reputation as one of the few indigenous bivalves which yield the beautiful productions whose name it bears. In ancient times Britain enjoyed some celebrity for its pearls, as they constituted one of its attractions for Julius Cæsar, who, however, does not seem to have reaped a very rich harvest, so far as quality went, though he obtained enough in quantity to cover with them a buckler, which he dedicated to Venus Genetrix, and suspended in her temple. The pearls used for the construction of his present were probably such as Roman ladies would have scorned to wear, although they were ostentatiously offered to the goddess of beauty; for Pliny, who narrates the circumstance, states at the same time that the pearls from Britain were small and lustreless, and not to be compared with those from the East. Tacitus, in his Life of Agricola, describes the pearls of Britain as '*subfusca ac liventia*;' and among ancient Christian writers they are mentioned by Origen and Bede. Pennant, and other writers, who have treated of pearls, have all taken it for granted that those mentioned by the ancient authors quoted were derived from the *Unio*. This, however, is by no means clear, and Cæsar's buckler was more probably covered with pearls from *Mytilus edulis*, very much inferior in quality and size to those from the fresh-water Pearl Mussel, and agreeing better with the disparaging account of them in Pliny. Those mentioned by Camden, as occurring at the mouth of the Irt, in Cumberland, seem to have been of the same nature. The pearl-fishery at the mouth of the Conway [to which I have already referred] also concerns the *Mytilus* and not the *Unio*. Higher up the latter river, however, and in many rivers of all parts of the kingdom, especially in the neighbourhood of mountainous districts, the *Unio* has been at various times fished to a great extent for pearls, and, in all probability, the fame of British pearls that attracted the Roman conqueror was due to the products of the shell before us. The best account of these fisheries of the freshwater Pearl Mussel is contained in a curious paper in the seventeenth volume of the 'Philosophical Transactions,' (1693,) written by Sir Robert Redding, and communicated by Dr. Martin Lister. This paper has been often referred to by subsequent writers, who, however, seem to have made use of Pennant's short notice of it only, which itself was taken from the abridgement, and not from the original. It is a remarkable paper, on account of the correctness of observation displayed in the personal statements of the author, who seems to have been a person with considerable natural-history powers. His description of both shell and animal is curiously correct as far it goes. He states that they were fished in the rivers of Tyrone, Derry, Donegal, near Dundalk, near Waterford, and in Kerry. The poor people fished them in the warm months before harvest time, when the rivers were low. They took them with their hoes, or wooden tongs, or by thrusting a stick into the shells which they caught sight of among the stones as they lay in part opened, with the white foot protruded, 'like a tongue out of the mouth.' Sir Robert saw them lying on their sides, and his informants described them as 'set up in the sand like eggs in salt, with the sharp edge downwards, and the opening side turned from the torrent.' One in a hundred might contain a pearl, and about one in a hundred of the pearls was tolerably clear. There were no pearls in the young mussels. 'Some gentlemen of the country made good advantage thereof, and I myself whilst there saw one pearl bought for fifty shillings that weighed thirty-six carats, and was valued at forty pounds. Everybody abounds with stories of the good pennyworths of the country, but I will add one more. A miller took out a pearl which he sold for four pounds ten shillings to a man who sold it for ten pounds, who sold it to the late Lady Glenealy for thirty pounds, with whom I saw it in a necklace; she refused eighty pounds for it from the late Duchess of Ormond.' 'The pearl,' Sir Robert observes, 'lies in the toe, or lesser end, at the extremity of the gut, and out of the body of the fish, between the two films or skins that line the shell.' He remarks that they correspond with calculi in other animals.

"The pearls of the Conway had great fame. According to Pennant a notion prevails in Wales, 'that Sir Richard Wynne, of Gwydir, Chamberlain to Catherine, queen of Charles the Second, presented her majesty with a pearl from the Conway, which is to this day honoured with a place in the regal crown.' He says the Pearl Mussels are called by the Welsh *Cregin Diluw*, or Deluge Shells, as if left there by the flood. Mr. Wilson, of Warrington, in 'Loudon's Magazine of Natural History' for June, 1830, says they are taken in the upper part of the Conway, near Llanrwst, but the search is very precarious. He mentions a Scotch pearl half an inch in diameter. In Scotland, the Tay was the seat of a pearl-fishery, extending from Perth to Loch Tay. 'It is said,' writes Captain Brown, 'that the pearls sent from thence to London, from the year 1761 to 1764, were worth ten thousand pounds sterling; and it is not uncommon at the present time to find pearls in the Teith and Tay worth from one to two pounds each.' The variety *Roissyi* of this Unio was formerly much sought for in the river near Braddan, in the Isle of Man, on account of its pearls."*

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* Forbes and Hanley; Brit. Moll. ii. 149; *et seq.*

FAMILY CARDIADÆ.

(*Cockles.*)

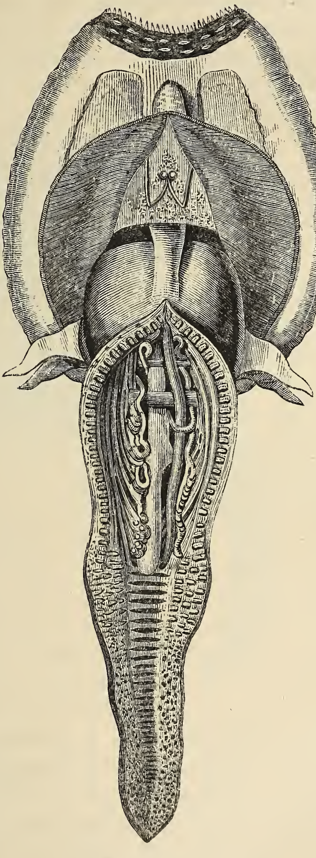
This is a large, important, and, generally speaking, well-defined group of bivalves, the characters of which are thus given by Cuvier. In all the mantle is open anteriorly, but posteriorly it presents two siphons or orifices, one for respiration, the other for the *egesta.* These form tubes sometimes distinct, sometimes united into a single mass. There is always a transverse adductor muscle at each extremity of the shell, and a foot which generally serves for the purpose of locomotion. It may be laid down as a rule, that the species with elongated siphons live buried in the mud, or sand. This condition of organization may be recognised on the shell, by the more or less developed contour which the impression of attachment of the borders of the mantle describes, before uniting with the impression of the posterior transverse muscle;" or, in other words, by the course of the pallial impression.

These Mollusks are all marine, with one or two doubtful exceptions; they frequently attain large size, and are valued for the delicacy and wholesomeness of their flesh; their abundance often renders them easy to be procured.

GENUS *CARDIUM.*

The shells of this well-known genus are globose and heart-shaped: the valves are equal, with beaks rolled in towards each other. The hinge is formed by four teeth in each valve, of which the two primary ones called cardinal are oblique, and one lateral remote on each side. The valves are almost always covered with well marked ribs alternating with furrows, which radiate from the beaks to the margins. These ribs are sometimes studded with spinous scales. The ligament is external and conspicuous though short.

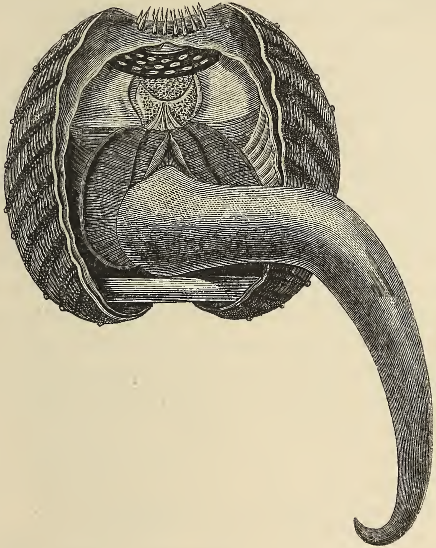
The animal is shaped much like the shell, being round and swollen, with the mantle open in front, the edges of which are usually plain, but strongly fringed in the neighbourhood of the two siphons; the latter are short, slightly separated and fringed around the edge. The foot is very large, cylindrical, with a conical tip directed forwards. It is bent, with an


FOOT-MUSCLES OF COCKLE.

abrupt elbow near the middle. These animals inhabit sandy or muddy shores, in which they live immersed at a moderate depth, or covered only by the tide at high-water. The powerful and versatile organ known as the foot is admirably adapted for the situations in which they reside. This organ in the present family is developed to a very great size, and is moved by an immense number of muscles of the most elaborate structure and arrangement, as will be seen by the preceding engraving of the dissected foot in a native species, *Cardium rusticum.*

In order to enable the animal to burrow in the sand, the foot, by means of its conical point, is thrust beneath the surface. When stretched to its utmost, it is bent into a hook, the whole organ is then forcibly contracted, and the animal, shell and all, is thus dragged a little way down into the yielding sand. This process is successively repeated, until the animal is sufficiently buried. But the foot can be made an instrument of locomotion, of quite another kind. The Cockle is a vigorous leaper, having been known to clear the gunwale of a boat when laid on the bottom boards. In order to effect this, the end of the foot bent into a hook is pressed firmly against the plane on which the animal is lying, in the position represented in the following engraving. The foot is then stiffened, when a sudden spring-like action of the elongating muscles jerks the animal into the air, with a force and agility that cannot fail to surprise those who witness it for the first time.

The Cockles are widely distributed, being found in nearly every sea, but their great metropolis is in the Indian Ocean, whence, as from a centre, the number of species diminishes in the ratio of distance. About two hundred species exist in collections, of which about ten are found on the British coasts. The shells of this genus are generally remarkable for elegance of form, and often



COCKLE LEAPING.

for brilliancy of colouring. Our British species are among the handsomest of our bivalves. "There is a pleasure," observe the learned authors of the British Mollusca, "in investigating such a group as this, wherein we find not only the greatest variety, but also the greatest distinctness and consequent certainty of specific determination."

All the species are believed to be wholesome as human food, and our own commonest species, *Cardium edule*, is very extensively sought after by persons not always of the lowest class in this country. It is said to be equally good raw or cooked, and its attractions when pickled, to bipeds of more than one class, are recorded in an amusing story.

A certain Parrot's loquacity had made her a favourite with all the members of a family, except the cook, whose resentment was incurred by Poll's thievish propensities. A jar of pickled cockles was on a shelf in the cupboard, and whenever the door was casually left open, the watchful bird failed not to pay it a visit, though always scolded when found out. One day Cook, coming suddenly into the kitchen, caught Poll in the act of emerging from the cupboard. Unable to restrain her wrath, she cried, "What! you've been at the pickled cockles again, have you?" and at the same instant dashed at the offending bird a tureen full of hot soup which was in her hand.

The poor bird was grievously scalded, and the consequences were the loss of all the plumage of her head, and of all her wonted garrulity. Not a word was uttered for weeks, and it was feared she had become hopelessly silent, when, one day, just as the new feathers of her head were beginning to sprout, a gentleman who was *bald* happened to call. Struck with the similarity of condition displayed by the stranger's smooth crown to her own, Poll broke forth, vociferating with peculiar emphasis, "What! *you've* been at the pickled cockles, have you?"

FAMILY CYPRINADÆ.

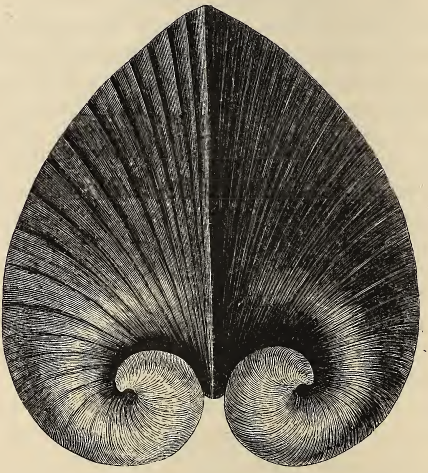
A group of fine shells, many of which are of large size, is thus named after the principal genus, *Cyprina* of Lamarck; though the appellation of the genus and that of the family are alike objectionable, as they have long been pre-occupied with the slightest possible terminal difference by the family and genus of the Carps among Fishes. The Mollusks of this group are distinguished by thick solid shells, often clothed with an epidermis, but usually smooth on the surface, or if sculptured, only with concentric lines running parallel to the edges of the valves. They vary in colouring, some being brilliant, others sombre. The hinge has strongly developed teeth, and an external ligament. The pallial impression is scarcely sinuated in its course. "This depends on a peculiar feature in the organization of the animal, which has, instead of distinct and produced siphonal tubes, only rudimentary ones in the shape of two scarcely separated orifices." The foot is thick and tongue-like.

GENUS *ISOCARDIA.*

This genus presents many points of affinity with the Cockles, and some with the great Clamps (*Chama*) of tropical seas. The shells are large, very convex, almost globose, heart-shaped, with the beaks much inrolled, curving forwards and outwards; the hinge is composed of two flattened teeth. The animal will be described presently.

The form of the valves has given the name of Heart-shell to the only British species, *Isocardia* *cor;* it ranks among the largest of our Mollusca, being sometimes found nearly three inches in length, and the same in breadth and thickness. It is of an uniform dark brown or liver-colour.

The following interesting account of the animal and its habits was communicated by the Rev. James Bulwer to the second volume of the "Zoological Journal."



HEART-SHELL.

"Mantle completely lining the shell, double at the outer edge; exterior fold divided in front, open at each end; at the posterior end forming two short siphons or tubes, ciliated at the upper orifices; colour, yellowish white; margin, orange. Foot very muscular, broad, triangular, compressed, pointed, orange. Branchiæ external, concealed between the mantle and the body. Body soft, completely included within the valves. On being placed in a vessel of sea-water, the valves of the shell gradually opened to the extent represented in the drawing [about one-fourth of an inch]; the feelers or ciliated fringe of the upper orifice of the mantle moved slowly, as if in search of animalculæ. Having remained in this situation about ten minutes, water was ejected with considerable force from the lower orifice, which till now had remained motionless. The expulsion of the water appeared to be effected by a sudden contraction of the muscles, because this was never done without the valves nearly closing at the same instant. After a few seconds the valves gradually returned to their open position, and remained quiescent as before, till the water was again ejected with a jerk; this alternating process was repeated at unequal intervals during the whole time my specimens were under examination, but at shorter intervals on receiving fresh supplies of sea-water, when I suppose food (its quality I could not ascertain) was more abundant.

"The animal appears to be insensible both to sound and light, as the presence and absence of either did not at all interrupt its movements; but its sense of feeling appeared to be very delicate: minute substances being dropped into the orifice of the mantle instantly excited the animal, and a column of water strongly directed expelled them from the shell. With so much strength was the water in some instances ejected, that it rose above the surface of three inches of superincumbent fluid. Animal small in proportion to its shell, occupying when dead barely a third of the space enclosed in the valves. Its mantle is slightly attached to the shell, and to the epidermis at the margin, and appears to be kept distended, and in contact with the interior of the valves, by the included water. The valves fit so closely that the animal can remain two days or more without permitting a single drop of fluid to escape. Locomotion very confined; it is capable, with the assistance of its foot, which it used in the same manner (but in a much more limited degree) as the *Cardiacea*, of fixing itself firmly in the sand, generally choosing to have the *umbones* covered by it, and the orifices of the tubes of the mantle nearly perpendicular.

"Resting in this position on the margin of a sandbank, of which the surrounding soil is mud, at too great a depth to be disturbed by storms, the *Isocardia* of our Irish sea patiently collects its food from the surrounding element, assisted in its choice by the current it is capable of creating by the alternate opening and closing of its valves." *

This fine species is nowhere very common; it is, however, occasionally taken in deep water off the extreme north of Scotland, and the extreme south-west of England, but it appears to be most abundant in the neighbourhood of Dublin. The other species are but few, and are found in the East Indian seas, and on the coasts of Australia. They inhabit mud and sand, at a depth ranging from ten to twenty fathoms.

FAMILY VENERIDÆ.

(*Venus Shells.*)

The best character of this extensive family is, according to Cuvier, that the teeth and laminæ of the hinge are approximated beneath the beak in a single group. In general they are more flattened and wider in proportion to their length than the Cockles, from which they differ conspicuously also in having the ribs never radiating towards the margin from the beaks, but always, where present at all, in concentric lines parallel to the margin. The ligament often leaves behind the beaks an oval depression, commonly called the corslet. The muscular impressions are strongly marked, and the pallial, or that which indicates the adhesion of the mantle, is much sinuated in its course.

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* Zool. Journ. ii. 359.

The animal has two siphonal tubes, capable of being protruded in a greater or less degree, sometimes united to each other; their extremities are fringed, though very slightly in some species. The mantle is widely open in front, for the projection of a large compressed foot, which serves for creeping.

This family is peculiarly rich in the number of its species; the genera *Venus* and *Cytherea* alone contain about a hundred each still existing, besides half as many more which are fossil. They are found in almost all seas, generally at a moderate distance from the shore, but extending from tide-marks to great depths. Our native species, *Venus striatula* and *ovata*, for example, live indifferently at low-water mark, and at the depth of a hundred fathoms. The tropical regions afford, as usual, the greatest number of species, and those most remarkable for beauty of form, sculpture, and colour, for all which, however, the majority of the family may be considered as preeminent among bivalves; whence the various appellations of the goddess of beauty, and similar names have been selected for the genera.

GENUS *VENUS*.

This extensive genus, including some of the most highly prized ornaments of cabinets, is distinguished by a shell usually somewhat solid, rounded in outline, or broader than long, equal-valved, but somewhat unequal-sided. The surface is generally adorned with many concentric ridges, often rising into strong ribs, and sometimes divided by radiating furrows. The margins are crenate, or scalloped; the beaks prominent. The hinge is formed of three diverging cardinal teeth in each valve. The muscular impressions are round, and well marked; the pallial sinus wide and pointed.

The animal is thick and globose, or oval; the edges of the mantle, which is open, are fringed. The siphons have fringed orifices, generally separate. The foot is not grooved.

About half-a-dozen members of this beautiful genus inhabit the British seas, which are considered as nearly the northern limit of its geographical range. Of these the finest is *Venus casina*, of which the valves are about an inch and a half in diameter. They are marked with strong concentric ribs, white, or occasionally painted with two or three crimson radiating bands.

Though this is a rare British shell, it has been taken at various localities all round the coast. I have obtained specimens from deep water off the Isle of Portland.

FAMILY MACTRADÆ.

In some respects these shells present close resemblances to those of the last family; but their outline is more triangular, and their surface is smooth, or merely marked with fine concentric lines. They are generally swollen; their substance varies much in texture; they are often invested with a strong epidermis. "The valves are connected together by a hinge, consisting of a forked diverging tooth in one, raised on a ligamental fulcrum lodged in a cavity, which is marginated in the other, a connecting cartilage and small external ligament completing the union." The pallial impression closely resembles that of the *Veneridæ.*

The animals of this family differ in the degree in which the mantle is open or closed in front; there are two siphonal tubes, which are connected and fringed at their orifices, and sometimes studded with pointed warts.

GENUS *MACTRA.*

The shell is more or less triangular, slightly gaping, with a smooth or concentrically striated surface, covered with an epidermis. The hinge is composed of a V-shaped cardinal tooth in one valve, locking into a marginated pit in the other, and of a long lateral tooth on each side of the same valve, which also fits into a deep groove with tooth-like margins. The sinus of the pallial impression is shallow but wide.

The animal has the mantle open as far as the siphons, its edges are fringed; the foot is strong, tongue-shaped and bent, capable of protrusion to a considerable extent. It is used, as in the Cockles, for burrowing in sand, which these animals do with great ease and rapidity. They are inhabitants of sandy shores in most seas, and the majority of them are found in the vicinity of low-water mark. Many of them are of a large size. We have a British species, *Mactra helvacea*, which attains the size of three inches by two and a half in diameter. This, however, is one of the rarest of our native shells, as *M. stultorum* is one of the most abundant. The latter is found on every sandy beach; it is about half the size just mentioned, somewhat triangular in outline, and varying much in colour, from plain drab to fawn-colour, marked with pale zones and white divergent rays.

FAMILY DONACIDÆ.

The shell is more or less triangular and compressed, broader than long, equal-valved, but unequal-sided, the hinder side being the shorter. The texture is strong and compact, the hinge variable, but always provided with conspicuous primary teeth.

The animal is generally richly coloured, with the mantle usually fringed; the siphonal tubes are separate and much developed, having their orifices adorned with deeply-cut tentacles. The foot is large, compressed, sharp-edged, and angular; the gills very unequal.

The species of this family, which are rather numerous, occur in all parts of the world, but most abundantly in the Southern Hemisphere. They live buried in sand or sandy mud, with the short side of the shell uppermost, the siphons being protruded, and range from low-water mark to a depth of ten fathoms.

GENUS *DONAX.*

In addition to the family characters already mentioned, the hinge in this the typical genus is composed of two primary teeth in one valve, and one in the other, with accessory lateral teeth. The ligament is external, short, and swollen; the muscular impressions are rounded, and the connecting pallial impression is straight, with a wide and deep sinus, hollowed out toward the hinder side. The surface is covered with an epidermis.

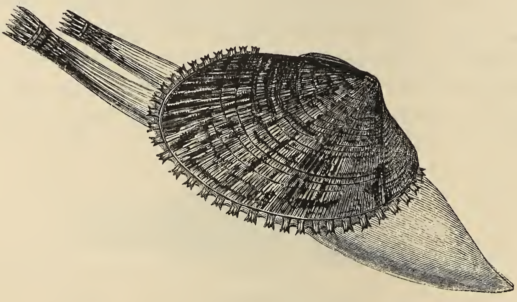
Among the more beautiful of British shells must be reckoned the Polished Donax (*D. politus*). It is oblong in form, usually a little more than an inch in breadth, and about half that length. It is always vividly coloured, but varies much; the most common condition is of a pale golden yellow, or faint lilac hue, spotted and clouded with reddish brown; a broad pale ray passes from the beak to the margin. The interior, which, like the exterior, is highly polished, is generally of a rich purple, sometimes varied near the beaks with golden yellow or orange. The animal is of a bright yellow colour, with orange stripes and pink fringes; the foot is large and white. This lovely species, nowhere common, is found in many places on our southern coasts.

POLISHED DONAX.

FAMILY TELLINADÆ.

(*Tellens.*)

This is a family very numerous in species, which are generally remarkable for the elegance of their form, the delicacy of their texture, and the brilliancy of their colour. The shell is generally much compressed, greatly produced in breadth, regular, and nearly equal-sided. The hinder side, which is often angular, has an irregular bend or fold at its lower border, more or less conspicuous. The beaks are very small, the hinge varies much, the ligament is swollen and lengthened, the pallial impression deeply hollowed. In general the valves are exceedingly thin and fragile, but painted with the most beautiful colours, often arranged in elegant patterns.



TELLINA.

The animal has the mantle moderately open, bordered with fringes; the gills are unequal on both sides. The siphons are very much lengthened, separate, and diverging, returning into a fold of the mantle; their orifices but slightly fringed. Notwithstanding the gaiety of the shell, the animal in this family is always arrayed in white, "simplex munditiis;" differing in this respect from *Donax*, the inhabitant of which usually rivals its shell in gorgeousness of hues.

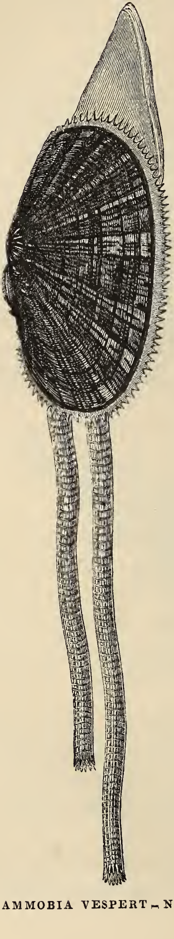
About seventy species are enumerated, which live at various depths, chiefly in the warmer seas; their habits closely agree with those of the preceding family. They are much preyed upon by the carnivorous *Gasteropoda*, as *Strombus*, *Buccinum*, &c., their thin shells exposing them with more than ordinary ease to the depredations of those boring Mollusks.

Genus *PSAMMOBIA*.

The shell in this lovely genus is more or less oval, the breadth commonly being double the length; the surface smooth, or delicately striated, and clothed with a thin epidermis. The hinge is composed of two cardinal teeth in one valve, receiving one from the other; the ligament is prominent.

The animal is white, with the mantle open, and slightly fringed; the very long siphons are marked along their length with lines of cilia, and fringed at their orifices. The foot is large and tongue-shaped.

These Mollusks have the habits common to all these allied families. They live, as their name indicates, in sand covered by the sea, from the water's edge to great depths. They are said to be active in their motions, burrowing with rapidity and ease in the sandy bed of the sea. We have several British species, one of the most elegant of which is sometimes called by collectors the Setting Sun (*Psammobia vespertina*), from its warm pink hue, and the pale bands which radiate from the beaks to all parts of the margin, like the rays which frequently stretch across the sky from the evening horizon. This species is commonly about two inches in breadth, and is not at all uncommon, burrowing beneath the surface near low-water mark on most of our sandy beaches, where the detached valves washed on shore by the tides are often picked up, and always admired.



PSAMMOBIA VESPERT-NA.

FAMILY SOLENIDÆ.

(*Razor Shells.*)

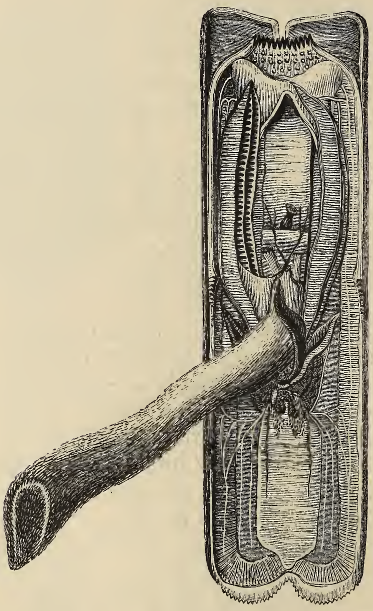
Every one who has paced along the water's edge on a sandy beach, is familiar with the shells which form the type of this family. Their extreme narrowness and length, (or, to speak strictly, shortness and breadth,) their parallel sides and truncate extremities are so different from the forms of all other shells, that even the unscientific observer regards them with curiosity and interest. The resemblance which the valves bear to the handle (*scales*) of a razor is obvious, especially in such species as are slightly curved. The valves are thin and brittle, covered with an olive epidermis which readily peels off. Beneath this the surface is marked with striæ recording the progress of growth, which, following courses parallel to all of the margins, impart a singular and peculiar aspect to these shells.

The animals have the mantle united for a portion of its edges, but allowing the protrusion of an enormous foot, which is thick, long, and somewhat club-shaped at the extremity. The siphons are short, united more or less completely, and fringed at the tips.

The species of this genus, which are not numerous, live in sandy beaches near the verge of low-water, or buried in the soil at greater depths. They are most powerful and skilful burrowers, often lying buried in a vertical position two feet deep, though their ordinary habit is to go only so low in the sand or mud, as to allow the extremities of the siphons just to reach the top. "They may be said to have regular burrows. When the animal is undisturbed, and the tide is in, it lies with the tubes at the entrance of its perpendicular hole. If it be disturbed, down it goes. In short, its life is spent in descending to the depths of its burrow, and ascending from it again, by means of the extension and contraction of its great muscular foot, which is situated at that part of the shell which is lowest."

GENUS *SOLEN.*

The characters already enumerated belong preeminently to this, the principal genus; one or two others which are associated with it presenting them with less distinctness and with more approximation to the neigbouring families. The hinge is usually composed of a well-defined cardinal tooth and a lateral fulcrum in each valve. It varies in position. The hinder muscular impression is ob-



SOLEN.

long, the anterior much lengthened. The pallial impression is sinuated.

Several species are common upon our sandy shores, and as their flesh is highly esteemed, they are taken in considerable quantities. When properly cooked, as by broiling, which is said to be the most effective method, they are among the most delicious of shell-fish.

The largest native species is *Solen siliqua*, which is occasionally found eight inches in breadth, and one in length. It may seem preposterous thus to use the terms breadth and length, but the structure of the shell as compared with other genera compels such an application. The valves are nearly straight, smooth, whitish, with purplish concentric bands, covered with a yellowish epidermis. The animal is large, and of a yellowish white hue.

" This shell is common on most of our sandy shores, found buried to the depth of a foot or more, near low-water mark; it frequently elevates one end a little above the surface, and protrudes its body in search of food: upon being disturbed, it suddenly recedes. This place is known by a small depression on the surface. In many places it is sought after for food by the common people."* " The mode in which a dish full of these esculents is rapidly collected by children, might successfully be imitated by conchologists, for other than culinary purposes; a long narrow wire, bent and sharpened at one end, is suddenly thrust into the hollows of the sands, indicative of the presence of these animals, and passing between the valves, the barbed portion fixes itself on retraction in the animal, and forces it to the surface." †

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* Montagu, Test. Brit. 47.

† Forbes and Hanley, i. 248.

The habits of a species closely allied to this (*S. marginatus*) were made the subject of investigation by the celebrated Reaumur, who published an account of them, illustrated by figures, in the "Mémoires de l'Académie des Sciences," for 1712. It burrows in sand near low-water mark, spring-tides, to the depth of from a foot and a half to two feet. The Solens lie in their holes nearly vertical, and their places are marked by perforations shaped like keyholes, corresponding to the form of the extremities of their united siphons. They are nearly vertical, and do not remain quiet, but rise up and down, now and then shifting themselves partly above the sand, as if to learn what is going on in the world above. When the tide goes out they sink deeper. The fishermen then endeavour to tempt them out as little boys would catch birds if they could—by putting salt on their tails. The salt penetrating the perforation, reaches and irritates the extremities of the siphons, and the Solen, annoyed and pained, rises suddenly to clear itself of the nuisance. His vigilant human enemy watches the moment, and seizes the opportunity—and the Solen, if he can catch it; but unless very quick in his motions, those of the Solen may be quicker, and once aware of the danger impending, the sensible shell-fish will not rise again, but submits patiently to the indignity of being salted alive, rather than run the risk of being caught and roasted, or else cut up for bait. But if it be not touched, a second dose of salt will cause it again to rise, which shows that knowledge and recollection of the danger is the impediment to its reappearance in the former case. Fishermen in England have a queerly absurd fancy that when the razor-fish feels the salt, it thinks the tide is coming in, and therefore rises in its hole.*

"If the Solen be taken out of its hole and placed upon the sand, it immediately prepares to rebury itself. It stretches out its foot to full length, and then bends it so as to use the extremity as a sort of auger. When the end has sunk into the sand, it draws up its shell, which, first oblique, and afterwards perpendicular, soon becomes immersed and rapidly disappears. M. Deshayes, during his Algerian researches, observed a remarkable instinct of *S. marginatus* to swim when desirous of changing its locality. When it finds itself on ground too hard to be penetrated by its foot, it fills the cavity of its mantle with water, and then contracting and closing exactly at the same time its siphonal orifices, elongates its foot; then recontracting that organ, it ejects the water with force from the tubes, and thus propels itself after the manner of a cuttle-fish for a foot or two forwards. Then if it finds the surface favourable, it bores and buries itself, but if not, it makes another leap to try its chance anew."†

Family Myadæ.

(*Gapers.*)

A large assemblage of genera of small importance, presenting considerable variation in external form and appearance, but having much more in common, may, in a work such as the present, be conveniently associated under the above title, the more especially as they are united in one family by M. de Blainville. He has named the group *Pyloridea*, including in it the *Solenidæ* already described, as well as the genera of which Messrs. Forbes & Hanley constitute the three families *Myadæ*, *Corbulidæ*, and *Pandoridæ;* the British representatives of the last-named two are few, and for the most part small, though remarkable for the curious form of the shell, which projects at one side as if distorted.

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* Forbes and Hanley, i. 244. † Ibid. i. 245.

The shell in the *Myadæ* is nearly regular and equal-valved, oblong, and somewhat coarse in appearance, gaping at the two extremities. The hinge is incomplete, the teeth being gradually effaced, but generally composed of one or two oblique diverging folds. The ligament is sometimes internal, sometimes external. There are two distinct muscular impressions connected by a pallial impression, widely sinuated behind. The animal is compressed, becoming in the different genera more and more cylindrical, as well as more completely closed, and prolonged backwards into two long siphons, which are ordinarily united, with fringed extremities. In front, the mantle allows the protrusion of a very small foot. The gills are narrow, free, and prolonged into one of the siphons.

All the animals of this family live plunged in the mud or sand, which is ordinarily covered by the sea. They rarely change their place or their position, invariably being vertically immersed, with the siphons above and the foot beneath. Many of the species grow to a large size, and as they are both wholesome and palatable, they are on some coasts much prized for the table.

GENUS *MYA*.

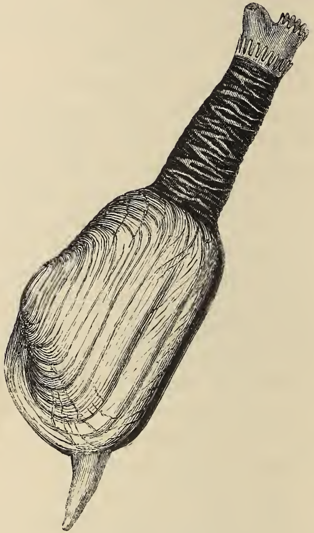
The hinge in this genus is composed of one or two oblique folds, diverging backwards from a horizontal spoon-shaped process, belonging to the left valve, and corresponding to a horizontal groove or socket in the right. The ligament is internal, inserted between the socket and the spoon-shaped process. The shell is generally white, exhibiting rude concentric lines of growth, and covered with a wrinkled epidermis, which is continued over the mantle and tubes of the animal.

The mollusk, thus encased in a thick and leathery case, presents a close resemblance to one of those *Tunicated Ascidiæ*, which I shall presently notice, with the addition of a bivalve shell; "and no better mode could be devised of impressing on the tyro in malacology the close affinity of two great sections, so unlike in most of their proper members, than the placing before him, side by side, examples of the genera *Mya* and *Cynthia.*"

The species of this genus are eaten not only by man; Otho Fabricius informs us, that on the inhospitable shores of Greenland, where they are numerous, they are greedily devoured by the walrus, the arctic fox, and by many predaceous birds, as well as by large fishes.

We have two native species, both of considerable size, of which the larger is the Sand Gaper (*Mya arenaria*), which attains a breadth of four inches, and a length of nearly two and a half. It is a coarse shell, of an earthy reddish or yellowish hue, stained with dirty black, and marked by irregular lines of growth. The animal, when its epidermis is stripped off, is yellowish-white, the orifices tinged with red; the investing coat is brown, rough, and wrinkled.

This Gaper is common on many parts of our seashore, in gravelly, clayey, or sandy ground, at low water, particularly near the mouths of rivers; and, where it occurs, it is usually abundant. At Southampton they are dug up and sold for food, under the name of "Old Maids." Their burrow, which descends to the depth of a foot or more, is indicated by a slight depression on the wet surface, from which, on the approach of a footfall, a jet of water from the siphonal tube is spouted. A narrow spade or fork is instantly plunged down in an oblique direction, with force sufficient to reach the animal, which is then raised with a jerk, an evicted tenant.



SAND GAPER.

One of the rarest of British bivalves (*Panopæa Norvagica*), allied to *Mya*, is an inhabitant of deep water, and is interesting for its unusual square form, and for its large size.

The following graphic account of Mr. Bean's discovery of this extremely scarce species is extracted from the "Magazine of Natural History," wherein the shell was first actually published as a native of our seas: "We have obtained at Scarborough three specimens of this, in every sense of the word, gigantic prize. To some of the fishermen of our coast it appeared to be well known by the name of the *bacca-box*, from a fancied resemblance to one of their most useful household goods. They were all caught by the hook, and rescued from destruction in a singular manner. The first was destined for a tobacco-box; the second had the honour of holding the grease belonging to the boat-establishment; and the third, after amusing them (the members of a philosophical society) by squirting water to the ceiling, was at last seen by a learned friend, purchased for a trifle, and generously placed in [illegible] cabinet. The animal we have not seen, but its colour is black." Three additional individuals have since then been obtained by Mr. Bean from the same locality, and two single valves have been dredged by Mr. M'Andrew in ninety fathoms water, twenty-five miles east of Zetland. It is likewise captured, though very rarely, in deep water off the Northumberland and Durham coasts (King and Alder).*

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* Cited in Br. Moll. i. 177.

FAMILY GASTROCHÆNIDÆ.

(*Stone Borers.*)

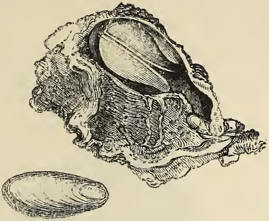
It is characteristic of all the families of Mollusca lately noticed, that they live habitually concealed in burrows of their own making. These burrows have, however, been commonly perforations in a yielding medium, such as sand or mud, easily and rapidly made by the animal, and obliterated as soon as relinquished.

The species of the family last described occasionally penetrate more resisting substances, such as clay, and even chalk. But I have now to describe genera which have the power of perforating the hardest and most solid rocks. Some species, however, both of this and of the succeeding family, though decided stone-borers, occasionally content themselves with burrows in the softer materials.

In the family before us the shell is equal-valved, but very unequal-sided, the valves usually gaping, and connected by a hinge, which varies exceedingly, sometimes being merely rudimentary, at others having cardinal teeth. These latter, however, when present, are in some species lost under certain conditions of growth.

The animal is oblong or club-shaped, with siphons capable of great elongation, and united through their whole length. The mantle is closed except to give existence in front to a minute foot.

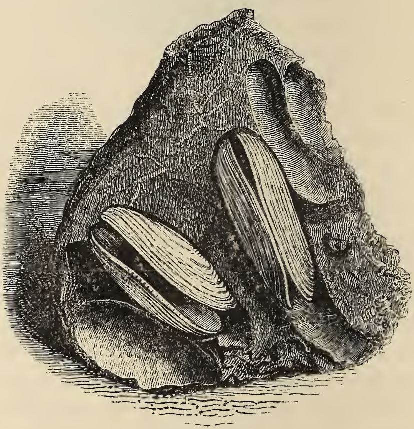
In the genus *Gastrochæna,* represented by one native species, the gallery perforated in the stone is lined with a deposit of calcareous substance, which forms a shelly tube frequently projecting from the stone, and serving for the protection of the siphons when they are extended. Such an one is now before me, which has been in my possession in a living state for several months, during which time it has slightly increased the length of its projecting tube by the addition of shelly matter. Internally the tube gives indications of a division into two, but the partition does not extend to the middle from either side. The crimson tips of the siphons may often be seen when the animal is undisturbed, just reaching to the tip of the tube, or projecting in the smallest degree beyond it. The investing tube is found, on carefully breaking the stone, to enclose the animal with its valves in a sort of flask or bottle. This species (*G. modiolina*) is reckoned among our rarer shells.



GASTROCHÆNA.

Genus *Saxicava.*

No accessory tube is formed by the animals of this genus, which live in the hardest rocks, especially those of calcareous formation. The shell is oblong and gaping, with prominent beaks; the hinge furnished at one period of life with cardinal teeth. The ligament is external and projecting. The animal is oblong, with the mantle closed, except in front, where exit is afforded for a minute finger-like foot, furnished with a byssal groove The siphons are united, and their orifices, which are large, are margined with a fringe of simple filaments.



SAXICAVA

" The *Saxicavæ*," observe the authors of the British Mollusca, " are borers, although the habit of boring does not seem necessary to their existence, since we find them very commonly free. If there be a crevice, however, in rock, shell, coral, or sea-weed, into which they can thrust themselves, they do so ; and if near a limestone rock, perforate it, and form crypts, in which they live. Mr. Osler states that, when young, they are very active animals, and soon commence to perforate. Both that gentleman and Mr. Garner have noticed that their excavations are not round, nor the sides smoothed off, like those of the holes made by *Pholas.* As for us, we only know of their boring into calcareous rocks, but Mr. Clarke has noticed an instance of their perforating triassic sandstone at Exmouth. Wherever we have a sea-coast of mountain limestone, the surface of the rocks is almost invariably found riddled by *Saxicava.* The whole front of the Plymouth breakwater has been attacked by it, and much alarm for its safety excited. Mr. Couch observes that the *Saxicava* never bores deeper than six inches, and that, consequently, unless a new surface be exposed by the destruction of the perforated part, there is not much danger. Owing, however, to the thinness of the partitions, which often are the only separation between the crypts of these mollusks, there is a great probability of the action of the sea rapidly forming new surfaces in such cases. How they bore has been as much discussed as the question how *Pholas* bores. The general opinion has been, that *Saxicava* bores by means of an acid secretion ; an opinion held by many who will not admit the probability of such an agent being used by the *Pholadidæ.* Mr. Osler, though inclined to such a view, could detect no acid, nor, for reasons previously stated, is it likely. Mr. Hancock, as we have seen when treating of *Pholas*, expressly asserts that the *Saxicavæ* bore by rasping, effected by means of siliceous particles contained in the anterior part of the mantle. Mr. Couch entertains a similar view. We have not been able to satisfy ourselves of the presence of such particles, though inclined to regard such a view with favour, as in this case the surface of the shell does not seem devised for rasping, as is that of the shells of the *Pholadidæ*."*

FAMILY PHOLADIDÆ.

(*Borers.*)

The members of this family have a very close affinity with those of the last, both in structure and habit, and have indeed been often united with them by zoologists. They possess peculiarities, however, which make their separation more natural. The genera differ among themselves more in outward appearance than in organization; they have the body usually lengthened in various degrees, and produced behind into very long siphons, which are united through their length. The mantle is closed except in front, where the foot protrudes; this organ is club-shaped, and has the extremity obliquely flattened, so as to form a broad disk; it is sometimes largely developed, at others minute. The valves are equal, but very one-sided, always gaping at both extremities; the hinge is without teeth, and there is no proper ligament; each valve is furnished with a curved calcareous process beneath its summit, and at the back of the shell there are generally two accessory plates resembling valves.

The mollusks of this group are as indomitable borers as the *Gastrochænadæ*, but they less exclusively confine themselves to hard substances.

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* Brit. Moll. i. 138.

Indurated mud, clay, and wood are perforated by these animals as well as stone, and their boring habits render them objects of painful anxiety to those who are interested in submarine works. The ship-worm (*Teredo*), whose terrible ravages have been already alluded to (*see ante*, p. 41), is a member of this family, though the great elongation of its body, the minuteness of its valves, and the shelly tube with which it lines its burrow, long caused it to be associated with the Worms (*Annelida*), rather than with the Mollusca.

The fullest and most carefully prepared account of the natural history of this animal was communicated by Mr. W. Thompson to the Edinburgh New Philosophical Journal, from which paper the following interesting details of one of our British species (of which we have unfortunately no fewer than six) are extracted :—

" The greatest diameter of the testaceous tube or case, at the larger end, is seven-eighths of an inch ; at the smaller, it varies from one and a half to two lines. All of the specimens have from one and a half to two inches and upwards of the smaller end of the tube greatly contracted within by laminæ, also the partition producing the double aperture extending but a few lines from the very extremity. The greatest thickness of the shell is at the smaller end, where, at the commencement of the laminæ, its consistence is from one-twentieth to one-fortieth part of an inch: from this it becomes gradually thinner towards the greater end, which in the very largest specimens is found to be closed up, but in several others there is no deposition whatever of testaceous matter for some distance from the termination of the cell. In one perforation, about twenty inches long, the body of the animal has had no testaceous covering for the last three and a half inches; in two other cells, of about two feet, no deposition appears for four and a half, and four inches and three quarters from their termination. All the timber at Portpatrick in which the *Teredo* had formed its habitation, is pine, and perhaps to this circumstance the superior size of the animal may chiefly be attributed. Though it is well known that the *Teredo* bores in the direction of the grain, it may be observed that it does so whether the position of the wood be perpendicular or otherwise. Captan Fayrer remarked, that it has a decided disposition to work horizontally. It is, however, often obliged to deviate from a straightforward course, to avoid such obstructions as nails, timber-knots, and tubes of its fellows, and make a winding or angular habitation according as such impediments occur; but these circumstances seem not eventually to impede the progress of the animal, as some of the very largest specimens I have examined are the most tortuous. During the nine or ten years that the Teredo has been established at Portpatrick, it has not degenerated; as specimens just received, which were alive in their native element a few days ago, are of equal size to those sent from the same place five years since, showing that it has not been affected by the cold of the winter season, as we might reasonably expect were the animals truly exotic. If this animal had originally been introduced, and has been preserved only by occasional importations, should we not rather look for it in those parts of the United Kingdom where vessels from every quarter of the globe are congregated, than in the obscure harbour of Portpatrick, which has never been visited by a foreign craft?"*

GENUS *PHOLAS.*

The shells of this genus are of delicate and fragile texture, and of a pure white hue, when undefiled by extraneous substances. The valves are much developed behind, gaping at both ends, but especially in front. Their exterior surface is rough, with transverse scaly ridges and furrows. A spoon-shaped process springs from beneath the beaks in each valve, directed forwards. The beaks are covered by a callosity, and there are accessory plates or valves at the back of the shell.

The animal is thick and club-shaped, with long siphonal tubes united externally into one. The foot generally is large, thick, oblique, and flat at its extremity. The burrows in this genus are never lined with a shelly coat.

Frequent mention has been made in the preceding pages of the siphonal tubes, with which many genera of *Conchifera* are furnished; and it has been explained that, whether apparently united in one or obviously distinct, these tubes are the external organs accessory to respiration. Even when apparently united, as in the present genus, a glance at the very tip shows that there are two openings, one of which is a little smaller than the other, and commonly this subordinate orifice diverges at a slight angle from the principal one.

The latter is the entrance, the former the exit for the water, a perpetual change of which is absolutely indispensable to the life of the animal. The interior of these tubes is said to be lined with innumerable delicate cilia; by the action of which the surrounding water is drawn towards the entering orifice, and conveyed in a strong current through the tube over the surface of the gills. Then, having been deprived of its oxygen, it is poured through the other tube and expelled in a jet at its extremity, by a similar machinery.

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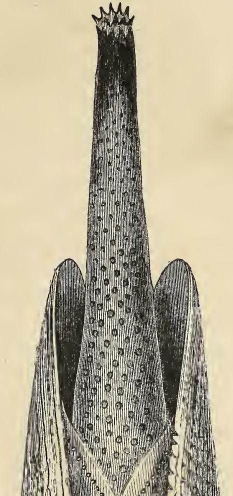
* Edin. New Phil. Journ. 1835.

This apparatus of double siphonal tubes is principally developed in those species which burrow, whether in sand, mud, wood or stone. As the burrowing bivalve usually, if not always, dwells in the interior of the passage it has excavated, it is needful that there should be a communication with the external water, and hence a hole is always found extending to the surface of the material bored. The entering and departing currents keep this passage clear, a process which in mud or sand might seem at first not very easy of accomplishment. It is facilitated, however, by the faculty which the boring bivalves have of lengthening the siphonal tubes at will; and the degree to which this may be accomplished depends on the depth of the cavity which the species is accustomed to make.

If we take one of the stone-boring Mollusca, a *Pholas* or a *Saxicava* for example, from its excavation, without injuring the animal, and place it in a glass vessel of sea-water, it will not be difficult to detect the currents in question, even with the naked eye; though a lens of moderate power will render them more distinctly appreciable. The vessel should be so placed as that the light may be nearly, but not exactly, opposite to the eye. By this arrangement the minute atoms of floating matter are illuminated while the back-ground is dark, and these by their motion clearly reveal the currents of the fluid in which they are suspended. A few moments' practice will enable even an unaccustomed eye to perceive the atoms converging from all points around, with an even but increasing velocity, towards the principal tube, down which they disappear like the streams of passengers and traffic in the neighbourhood of a great city, converging towards it as to a common centre of attraction by a hundred different routes. The current of the expelling tube is even still more marked in its character; a forcible jet of water is periodically ejected from this orifice, which draws the surrounding particles into its vortex, and shoots them forward to a distance of many inches. It is by the expulsive force of this anal current, chiefly, that the passage is kept free from the deposit of mud and other substances, which would otherwise soon choke it up.

A fresh supply of water for respiration, and its dismissal when no longer fit for use, are efficiently provided for by this contrivance. But since many particles of matter float in the water, which from their form or other qualities might be hurtful to the delicate tissues of the viscera to be traversed, how is the entrance of these to be guarded against in an indiscriminating current? A beautiful contrivance is provided for this necessity. The margin of the entering siphon, and sometimes, though more rarely, of the ejecting one, is set round with a number of short tentacular processes, varying indeed in their length, but the longest scarcely more than equalling half the diameter of the mouth of the tube. In *Saxicava rugosa*, which bores through and through, with small holes, the hardest limestone of our coast, these tentacular appendages are found fringing both the tubes. The tentacles in this species are simple, and appear as if cut off transversely; and some are not more than half as long as the others, with which they irregularly alternate. The object of this diversity in length will be manifested presently. In *Pholas parva*, the processes are few and short, and are confined to the receiving tube, from the interior margin of which they project, towards the centre. But it is in *Pholas dactylus*, a noble species of large size, that excavates the softer rocks on our shores, that this apparatus is developed with peculiar beauty, and its use is made most clearly manifest. The tentacular filaments are in this case also confined to the oral tube. They are numerous, each forming a little tree, with pinnate branches, bearing no small resemblance to the flower of feathery branchiæ, that expands around the mouth of a *Holothuria*. These branched tentacula are ordinarily bent down across the mouth of the tube, the longest of them just meeting in the centre; alternating with these are placed others of similar structure, but inferior size: and the interspaces are occupied by others smaller still, and simply pinnate; so that when the whole occupy their ordinary transverse position, the small ones fill up the angles of the larger, and the branches of all form a net-work of exquisite tracery, spread across the orifice, through the interstices or meshes of which the current of entering water freely percolates, while they exclude all except the most minute floating atoms of extraneous matter.

The mode in which the boring Mollusca execute their perforations is yet a matter of uncertainty. The principal hypotheses that have been put forth on the subject have been already briefly enumerated, but it may not be amiss to add an expression of opinion on their value, and a careful summing up of the evidence, by zoologists eminently worthy of deference, the able authors of the "British Mollusca."


PHOLAS.

"Of all these theories," observe Messrs. Forbes and Hanley, "the chemical one, so far as a secreted solvent is concerned, bears least examination in the case of the *Pholadidæ*. The substances perforated are wood, limestones, hard and soft, argillaceous shales, clays, sandstone, and (in the case of a *Pholas*, in the magnificent collection of Mr. Cuming) wax. The notion of a secreted solvent, that would act indifferently on all these substances is, at present at least, purely hypothetical; and, since all attempted tests have failed to detect an acid, gratuitously so; for we can hardly suppose that any of those who have taken this view of the cause would maintain, that the animals have the power of secreting different acids at will, according to the substance they have to attack. Yet this notion has been most favoured by naturalists, who, sceptical as to the perforating power of such fragile instruments as are the shells of many of these creatures, endowed the animals with supernatural chemical qualifications. Even good experimental observers—Mr. Osler for one—whilst they proved that the *Pholas* could bore mechanically by the rotation of its valves, could not free their minds from the prejudice in favour of a solvent. The important statement put forward by Mr. Albany Hancock, respecting the instruments by which Mollusca bore, and which, so far as *Gasteropoda* are concerned, appear to furnish us with a true explanation,—namely, that it was effected by means of silicious particles, variously arranged in certain portions of the animal's body,—led us to hope that a better cause than any yet alleged had been discovered. But we cannot bear it out with respect to the *Pholadidæ*. We can find no such particles in the mantle of the *Teredo*, nor have any been noticed by Home or Deshayes, or by the most recent observers, Fray and Leuckart, who paid especial attention to the structure of the tissues in this genus. Nor could we, although aided by the anatomical and microscopical skill of Mr. Busk, detect any silicious particles in either the mantle, foot, or siphon tube of *Pholas candida*. If present in any species, therefore, they are exceptional, so far as the genus *Pholas* and its allies are concerned. The shells of several British species of *Pholas*, and that of *Pholadidea*, have been chemically examined by our friend, Mr. Trenham Reeks, with a negative result as regards the presence of particles of silex in their substance, where, after the statement of Mr. Hancock respecting the structure of the mantle, we thought they might possibly be found. On the other hand, taking into consideration its mineralogical nature, as stated by M. Necker, there is no reason for supposing that the shell of the *Pholadidæ* is so weak a perforating instrument as some have fancied. With its peculiar form, and the saw-like asperities of its surface, especially of its anteal extremity, it is well adapted for an auger, when wielded fresh and elastic by its well-muscled animal inhabitant, whose foot, in all the members of this tribe, even in *Teredo*, where it is least developed, seems specially organized to serve as a fulcrum. We have no evidence that they perforate any substances essentially harder than their shells, or so hard. The sandstones in which they occasionally occur are either friable or marly, when fresh, though cabinet specimens seem so solid. The explanation of Necker accounts for their perforations in the hardest limestones. Wood, wax, and other substances in which they occur, offer no difficulty. The statements put forward respecting their boring in lava and granite, have long ago been shown to be mistakes. That they exhibit a rotatory motion, during the action of boring, has been proved by competent observers; and the cavities they excavate, if examined when fresh, invariably show transverse groovings, which could have been caused only by such motions. Currents of water, set in motion by cilia, doubtless aid materially the animal's operations, and possibly may be the means by which the larvæ effect their first lodgment; but, considering the arrangement of the parts of the body in the adult animal, it seems to us that Mr. Garner's view of their being the primary cause of the perforation, whilst the rasping of the valves is secondary, should be reversed. Such currents must be most effective in clearing away loosened and loosening particles. If there be any chemical action aiding, it must be due to the carbonic acid set free during the respiratory process. Evidence of a secreted solvent there is none."

To the same authority I am indebted for another interesting fact in the history of this genus.

" A remarkable property of the animals of this genus, and one which has long attracted notice, is their phosphorescence when placed in the dark. This phenomenon is exhibited by some other acephalous mollusks, and by the compound tunicated genus *Pyrosoma.* The light is of a bluish-white hue, and is regarded by Mayer to proceed from a luminous mucus, like that given off by the *Medusæ.* This mucus is thrown off into the surrounding water, so that the currents proceeding from the animal are luminous. Dr. Coldstream states, that the light is given out most strongly by the internal surfaces of the respiratory tubes, and that it is strongest in summer. Professor John Müller has observed, that when *Pholades* are placed in a vacuum, the light disappears, but reappears on the admission of air; also that, when dried, they recover their luminous property on being rubbed or moistened."*

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* Brit. Moll. i. 104, *et seq.*

CLASS V. BRACHIOPODA.

(*Arm-footed Mollusks.*)

THE animals bearing the above title are inhabitants of bivalve shells, one valve of which is frequently perforated, to give exit to a fleshy peduncle or stem, by which the animal is affixed to the rocks. When we open the two valves of the shell, we find each of them lined with a broad membrane, very thin, delicate, and semi-transparent, which together constitute the mantle. The edges of these membranes are thickened, and fringed with organs, already several times mentioned in these pages, and which we shall see assuming great importance as we investigate the economy of the lower tribes of animals. These organs are called *cilia*, and consist of very subtile and microscopically minute hairs, arranged in close series, and capable of moving in unison, with vibratile waves, and of thus producing rapid currents in the water.

At the bottom of the cleft formed by the two leaves of the mantle, the mouth is placed, on each side of which is a long fleshy process, fringed all along one side with delicate hairs. In some species, these *arms* (which give name to the Class) are enormously developed; they are free for their whole length, and are capable, at the will of the animal, of being coiled up in many spiral folds, or of being protruded from the shell to a distance equal to thrice its length. The mechanism by which they are unfolded is simple and beautiful. The stem of the process is hollow, and partially filled with a fluid, which being forcibly injected towards the extremity, by the contraction of a double series of muscles behind, the whole of the lengthened organ is straightened and projected.

Most of the species have a shelly frame-work within one of the valves, consisting of slender loops and arches, variously arranged, and more or less complex. This is intended to support the fringed arms, and to keep the valves open, or even to assist in opening them; for there is in this class nothing corresponding to the hinge-cartilage, which performs the latter function in the *Conchifera.*

Respiration in these animals seems to be performed by the mantle itself; the long fringed arms having apparently nothing to do with this office, notwithstanding their gill-like structure.

Some of the species are found in the shallows of sandy shores; but others inhabit the darkness and solitude of the deep sea; some of the *Terebratulæ* dwelling in water from sixty to ninety fathoms deep; while *Crania personata* has been dredged up from a depth of 255 fathoms. The respiration and nutrition of animals that can subsist beneath a pressure so enormous, are subjects, as Professor Owen remarks, "suggestive of interesting reflections, and lead one to contemplate with less surprise the great strength and complexity of some of the minutest parts of the frame of these diminutive creatures. In the unbroken stillness which must pervade those abysses, their existence must depend upon their power of exciting a perpetual current around them, in order to dissipate the water already laden with their effete particles, and to bring within the reach of their prehensile organs the animalcules adapted for their sustenance."*

Genus *Terebratula*.

In this genus, which I select to represent the Class, the valves are unequal; and the lower one, more prominent than the other, is perforated to admit the passage of a short fleshy stem, by which the animal is firmly attached to rocks, and other foreign bodies. The shell is delicate in texture, more or less triangular, and symmetrical. The shelly frame-work of the arms, sometimes called by collectors the *carriage-spring*, is attached to the inner surface of the upper valve, or that which is not perforated.

Most of the species of this genus, as of the whole Class, are known only in a fossil state; those which are recent are widely diffused, and flourish in extremely warm and extremely cold climates, as well as those which are intermediate. Thus some are found in the Indian ocean, beneath the equator; while the *T. psittacea*, brought home from the late Arctic expedition, was dredged at Boothia in the Polar sea.

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* Comp. Anat. i. 279.

CLASS VI. TUNICATA.

(*Ascidian Mollusks.*)

The calcareous shell entirely disappears in the animals of this Class, their organs being enclosed in a case of leathery substance, more or less thick and tough, usually called the *tunic* or *test.* In general, they bear a close resemblance to the *Conchifera*, if the latter be deprived of their protecting valves, as has already been noticed in speaking of the *Myadæ.* The ordinary form which they assume is that of a leathery, usually semi-pellucid sac, with two openings, the one for the entrance, the other for the exit, of the nourishing water. The gills never appear in the form of free leaves, but constitute a kind of bag, the surface of which is covered with oblong cells or depressions, lined with cilia. Their circulatory system has this remarkable peculiarity, that it ebbs and flows: the blood, being driven from the heart through the vessels in one direction for a certain time, suddenly stops, and after a few moments pursues a retrograde course for a like period.

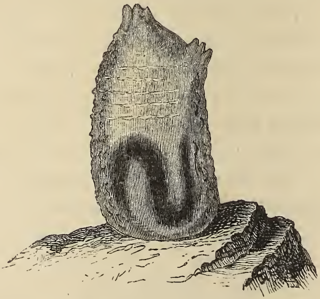
All the Tunicate Mollusca are marine; many of them are permanently fixed to other substances, others are permanently free; all, however, have the power of locomotion during the infancy of their existence. Some of the genera are single and isolated; others are social, always living aggregated in groups; and others are united into masses, organically possessing a compound life. Through these last-named the transition is easy and natural to the lowest forms of animal life, the Polypes; for the Class of animals denominated *Bryozoa* or *Polyzoa*, which form the exquisite aggregations of calcareous cells known as Sea-mats (*Flustra*), and their allies, are truly Ascidians in their structure, with their entering orifice surrounded by a radiated circle of ciliated tentacles.

Family Ascidiadæ.

Whoever has turned over stones at the extreme verge of low-water (and there is no student of marine natural history who has not) is familiar with uncouth pellucid bodies adhering to their under surfaces, that resemble bags, of a substance somewhat between leather and jelly. The dredger, however, is far more familiar with them, for scarcely can any part of the bottom of the sea be raked without an abundance of these curious creatures being brought up, varying much in size and colour. Some are sufficiently rude and uncouth, coarse and rough in texture, and dingy in hue; others are attractive, often of brilliant colours, of a semi-transparent clearness, resembling strange pellucid fruits, or masses of ice. They are always found adherent, either by the base of the sac or by its side, to foreign bodies, as stones, shells, and sea-weeds, and thus not only are they deprived of locomotion, but almost of all appearance of vitality, for no movement is perceptible in them externally, except the periodical opening and closing of the two orifices which give admission and exit to the currents of water for respiration and food.

The branchial sac occupies the upper part of the animal; its interior surface is divided into cells by plaits or ridges, which are clothed with cilia; its orifice is surrounded by a circle of tentacles, and its inferior extremity merges into the digestive tube. For as the food of these animals consists of microscopic organisms, which are drawn in by the entering currents, the same influx of water brings oxygen for the respiration, and food for the nutriment of the system.

The water, in yielding its vital properties, passes towards the bottom of the body, and then returning by an upward course is discharged through an orifice closely resembling the other in appearance, and situated near to it on one side. Both orifices can be completely closed at will, by being drawn together in wrinkles, and each is commonly surrounded with minute coloured specks, that are considered to represent eyes. These specks are usually eight around the receiving orifice, and six around the discharging one.



ASCIDIA VIRGINEA.

The species of this family are very numerous: nearly fifty are enumerated as British; and probably not half of the whole number have yet been described. One of the most common is *Ascidia virginea*, which grows to an inch and a half in length, and about three quarters in breadth. It is pellucid and crystalline, of a pale yellowish tinge, revealing through the test the branchial sac, spotted with crimson, and crossed with lines of white. It adheres to stones, dead shells, and living sea-weeds in deep water.

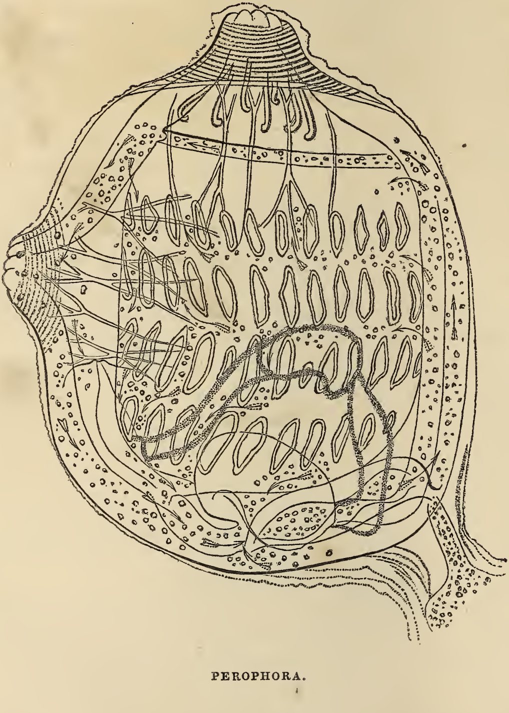
FAMILY CLAVELINADÆ.

(*Social Ascidians.*)

In essential points these resemble the preceding family, but the individuals are not distinct, but united by a common root-thread, from which they spring, like buds from a creeping root-stock. The thread creeps over the surfaces of stones, the stems of sea-plants, &c., continually growing by a lengthening of its extremity, and increasing by throwing out, either in groups or at regular intervals, a kind of buds, that develop into Ascidian mollusks, which commonly stand on more or less distinct foot-stalks.

The family may be illustrated by the accompanying figure, greatly magnified, of a tiny species (*Perophora Listeri*), found occasionally on our own coasts. I obtained the individual from which the figure was taken at Ilfracombe, attached to a fragment of sea-weed. It is, to the naked eye, a globule of clear jelly, not larger than a pin's head, yet disclosing, under the microscope, an elaborate system of organs for respiration, circulation, and digestion.

The rows of oval rings are the cells of the branchial sac, and the arrows show the course of the blood as it circulates from the oblong heart at the bottom of the body all around the system.



PEROPHORA.

Family Botryllidæ.

(*Starry Ascidians.*)

The stones that are ordinarily covered by the tide, and the coarser sea-weeds, such as the *Fuci* and *Laminariœ*, that grow at low-water, are very frequently studded with irregular patches of dark-coloured substance, gelatinous to the feel, and often somewhat brightly coloured, the more common hues being blue, purple, green, grey, and white. On closer examination, we find embedded in this mass, circles of stars, each consisting of a definite number of bright-hued, minute, oblong bodies, radiating from a common centre.

These masses belong to the genus *Botryllus*, the representative of the family before us; and each radiating point is an individual animal. From ten to twenty of such animals are ordinarily grouped together to form one of the wheel-like systems; and there are often as many systems in one encrusting mass.

The organization of these little animals is in general conformable to what has been already described; but the discharging orifice of each individual is placed at the opposite end from the mouth, and opens into the common centre, which, rising with a circular rim, expands and contracts as a discharging orifice for the whole of that system.

Several species of this genus are common with us, one of the most abundant of which is the *Botryllus polycyclus*, which is found encrusting the broad leaves of the common Tangle (*Laminaria digitata*). It is of a bluish purple hue, with the individuals marked by white rays.

Other genera in this family form similar encrusting masses, but the animals are placed in irregular tortuous lines instead of stars, and the two orifices are near together. Others do not encrust foreign substances, but are grouped in variously shaped knots, or fruit-like bodies, adhering to stones and shells.

FAMILY SALPADÆ.

(*Swimming Ascidians.*)

The body in this group is free, or not adherent; more or less cylindrical; with a thick external envelope, which is somewhat cartilaginous; transparent; having the two orifices, which are ordinarily very large and distant, nearly terminal, one at each extremity. The branchiæ, in the form of a narrow band, traverse obliquely the respiratory cavity of the receiving orifice to the aperture of the mouth.

M. de Blainville remarks, that one may easily perceive the relationship of this family to the other *Tunicata*, by supposing an *Ascidia* slit between the two tubes which terminate it, and then extended lengthwise. It is then, he observes, easy to determine the analogy of the apertures, of which neither the one nor the other is properly any more the mouth or the anus than in the *Ascidiæ;* but one (the widest, the greatest, and the most distant from the mouth), is the entrance of the incretory or respiratory tube, and the other is that of the excretory tube. He adds, that the species of this family are, like those of the preceding, susceptible of living solitary, or aggregated in a fixed manner, which would seem to make them composite animals, though they are not such; and he divides it into two tribes:—1. The simple Salpaceans (*Salpa*); 2. The aggregate Salpaceans (*Pyrosoma*).

"A great interest," observe Messrs. Forbes and Hanley, "is attached to the natural history of the *Salpæ*, on account of their singular mode of reproduction, discovered by the German naturalist Chamisso, and the extraordinary generalization to which that discovery in a great measure gave rise. Previous observers had noticed that these animals were sometimes found solitary, at others united together in long chains, composed of numerous individuals of similar form, each an independent being, though constantly associated, and linearly aggregated with its companions. These long chains swim through the tranquil water with regular serpentine movements; for the creatures of which they are composed contract and expand simultaneously, keeping time, as it were, like a regiment of soldiers upon parade. Each chain seems, consequently, to be a single being, acting through the influence of an unique will; and hence sailors often look upon it as a reptile; and in many seas the Salpa-chains are called sea-serpents. But when taken out of the water, the links of the chain fall asunder, the several distinct animals of which it is composed suddenly losing their power of adhesion. In consequence of accidents, broken-up chains and separated members of such communities are not unfrequently met with, in seas where *Salpæ* are numerous. But other *Salpæ* are also met with, very dissimilar in form, and never united together in chains. Now, the discovery of Chamisso was, that such constantly solitary *Salpæ* did not belong to species distinct from those united in chains, however dissimilar (and they are so dissimilar usually, as to appear even generically distinct), but were either the parents or the progeny, as the case might be, of the aggregate forms; that chained *Salpæ* did not produce chained *Salpæ*, but solitary *Salpæ*, which, in their turn, did not produce solitary beings, but chained. Consequently, as Chamisso graphically observes, 'a *Salpa* mother is not like its daughter or its own mother, but resembles its sister, its grandaughter, and its grandmother.'" *

More recent researches have fully confirmed the correctness of these observations, strange as they at first appeared. Nor are the facts so singular as they were then believed to be; for the same law (now known as that of the Alternation of Generations), has been found to prevail extensively in the Medusæ and Hydroid Polypes.

One or more species of this genus have been at various times observed in the seas which wash the British coasts; and the first detection of the genus we owe to the eminent geologist, Dr. McCulloch. His graphic description of the discovery is so interesting, that I shall give it with a slight abridgement, though it repeats some details already mentioned. The species was probably *Salpa runcinata.*

"Some marine animals occur in these seas which remain still unrecorded in the catalogue of British zoology. Among these, indeed, it is probable that a few will be found still undescribed by naturalists, since fresh additions are even yet occasionally made to our catalogue of these obscurer parts of the creation. Many of these animals have occasionally fallen under my notice; but amid pursuits which rendered it impossible to attend either to their examination or preservation. I have, however, preserved a memorial of one, as it appears to form a new species, in a tribe of which no individual has yet been observed within the limits of the British seas. It belongs, apparently, to the genus *Salpa*. . . .

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* Brit. Moll. i. 47.

"The mode in which the republic is linked together, is observed to be constant in each species; and it is sufficiently remarkable in this one, to distinguish it from the rest of the genus, as far as it is yet described. Each individual adheres to the preceding, by a regular sequence of superposition, lengthwise; so that the whole forms a long, simple chain, the adhesion continuing as in the ovarium, for some time after hatching. They were found from the middle to the latter end of August, and always linked together. It is probable that their separation takes place at a later season of the year, but I did not observe them in that state. The individual is amongst the most simple in shape of those yet described, presenting an oval-lanceolate and slightly rhomboidal flattened figure, without appendages. The anal opening is of a bright brown hue, and circular, being placed at some distance from the extremity; and when the chain is linked together, all these apertures are directed the same way. The animal is perfectly hyaline, and tender, and the adhesion of the chain so slight, that the individuals are easily separated. The act of swimming is known to result from the introduction and emission of water by each animal: and as the republic swims together by an undulating motion resembling that of a serpent—the chain often extending to many feet in length — it is evident that this motion must arise from the unequal manner in which the different individuals act throughout the whole line. . . .

"I had occasion to remark of this animal, that, like the *Medusæ* and analogous tribes, it cannot bear to be confined in a limited portion of water, as it died, even in the ship's bucket, in less than half an hour—a very remarkable circumstance in the economy of these imperfect animals.

"Hitherto, this genus is only known as the inhabitant of hot climates, and of the Mediterranean Sea. I found it in great abundance in the harbours of Canna and Campbelltown, rising to the surface in calm weather, and crowding the water as the *Medusæ* often do at the same time of the year. . . .

"I was desirous of observing whether this animal, like many other of the marine worms, emitted light, but had no opportunity of ascertaining the fact, as they seemed always to retire to the bottom at sunset, and those which were taken on board died (as I have already observed), in a very short time." *

The *Pyrosomata* are aggregated in another manner. They consist of lengthened individual Ascidians, united to each other at their basal part, and free at the opposite extremity, with their connexion so arranged as to compose numerous and regular rings, which concur to form a long, free cylinder, or tube, open at one extremity and closed at the other.

Cuvier states, that this great cylinder swims in the sea by means of the combined contractions and dilatations of all the individual animals which compose it. The branchial orifices are pierced near the points, and the anus opens into the interior cavity of the tube. Thus, says Cuvier, one may compare a *Pyrosoma* to a great number of stars of *Botrylli*, strung one after the other, but the whole of which would be moveable.

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* Western Isles, ii. 187.

Mr. George Bennett, in his interesting "Wanderings in New South Wales," after some valuable remarks on the luminosity of the ocean, proceeds as follows:—

"On the 8th of June, being then in latitude 30′ south, and longitude 27° 5′ west, having fine weather and a fresh south-easterly trade-wind, and the range of the thermometer being from 78° to 84°, late at night, the mate of the watch came and called me to witness a very unusual appearance in the water, which he, on first seeing it, considered to be breakers. On arriving upon the deck, this was found to be a very broad and extensive sheet of phosphorescence, extending in a direction from east to west, as far as the eye could reach. The luminosity was confined to the range of animals in this shoal, for there was no similar light in any other direction. I immediately cast the towing-net over the stern of the ship, as we approached nearer the luminous streak, to ascertain the cause of this extraordinary and so limited phenomenon. The ship soon cleaved through the brilliant mass, from which, by the disturbance, strong flashes of light were emitted; and the shoal, judging from the time the vessel took in passing through the mass, may have been a mile in breadth. The passage of the vessel through them increased the light around to a far stronger degree, illuminating the ship. On taking in the towing-net, it was found half filled with *Pyrosoma* (*Atlanticum?*), which shone with a beautiful pale-greenish light; and there were also a few shell-fish in the net at the same time. After the mass had been passed through, the light was still seen astern, until it became invisible in the distance; and the whole of the ocean then became hidden in darkness as before this took place. The scene was as novel as beautiful and interesting; more so from my having ascertained, by capturing luminous animals, the cause of the phenomenon.

"The second occasion of my meeting these creatures was not exactly similar to the preceding; but though also limited, was curious, as occurring in a high latitude, during the winter season. It was on the 19th of August, the weather dark and gloomy, with light breezes from north-north-east, in latitude 40° 30′ south, and longitude 138° 3′ east, being then distant about 368 miles from King's Island (at the western entrance of Bass's Straits). It was about eight o'clock P.M. when the ship's wake was perceived to be luminous; and scintillations of the same light were also abundant around. As this was unusual, and had not been seen before, and it occasionally, also, appeared in larger and smaller detached masses, giving out a high degree of brilliancy,—to ascertain the cause, so unusual in high latitudes during the winter season, I threw the towing-net overboard, and in twenty minutes succeeded in capturing several *Pyrosomata*, giving out their usual pale-green light; and it was, no doubt, detached groups of these animals that were the occasion of the light in question. The beautiful light given out by these molluscous animals soon ceased to be seen emitted from every part of their bodies; but by moving them about, it could be reproduced for some length of time after. As long as the luminosity of the ocean was visible (which continued most part of the night), a number of *Pyrosoma Atlanticum*, two species of *Phyllosoma*, an animal apparently allied to *Leptocephalus*, as well as several crustaceous animals (all of which I had before considered as intertropical species), were caught and preserved. At half-past ten P.M. the temperature of the atmosphere on deck was 52°, and that of the water 51½°. The luminosity of the water gradually decreased during the night, and towards morning was no longer seen, nor on any subsequent night."*

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* Wanderings, vol. i.

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